State of Kansas
Exceptional Event Demonstration Package
Goodland, KS
February 9, 2013

Department of Health and Environment
Division of Environment
Bureau of Air

December 10, 2015

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EXECUTIVE SUMMARY

In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls). In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review. The EER allows for states and tribes to "flag" air quality monitoring data as an exceptional event and exclude those data from use in determinations with respect to exceedances or violations of the NAAQS, if EPA concurs with the demonstration submitted by the flagging agency.

Western Kansas, due to its geographical location and semi-arid climate conditions is more susceptible to windblown dust events. These events are occasionally captured by various air quality monitoring equipment throughout the state, sometimes resulting in exceedances of the PM_{10} (airborne particulate matter having a nominal aerodynamic diameter less than or equal to 10 microns) NAAQS. The Kansas Department of Health and Environment (KDHE) believes that the dust event that occurred in February of 2013 exemplifies these types of events. This document contains detailed information about the windblown dust event that affected the Goodland PM_{10} monitoring site on February 9, 2013 in which the Goodland monitor exceeded the PM_{10} NAAQS. KDHE contends that the exceedance that was measured February 9, 2013, at the Goodland monitoring site was the result of natural events that were not reasonably controllable or preventable. This document describing the February 9, 2013 dust event was a collaborative effort involving staff from the Kansas Department of Health and Environment's Bureau of Air.

Section 1 of this document provides a summary of the exceptional event rules and requirements and lays out how those rules are met within this specific document.

Section 2 of this document introduces the conceptual model of the meteorological events that transpired during the period of February 8-9, 2013, providing a background narrative of the exceptional event.

Section 3 of this document provides data summaries and time series graphs which help illustrate that the event of February 9, 2013 produced PM_{10} concentrations in excess of normal historical fluctuations.

Section 4 of this document details the existing area agricultural control measures and demonstrates that despite the presence of these controls, the event of February 9, 2013 was not reasonably controllable or preventable.

Section 5 of this document establishes a clear causal connection between the natural events of February 9, 2013 and the exceedance of the 24-hour PM_{10} standard at the monitoring station. The evidence in this section (and the previous section on historical fluctuations) also confirms that the events in question both affected air quality and were the result of natural events.

Section 6 of this document builds upon the demonstration showing a clear causal connection between the natural event and the exceedance and concludes there would have been no exceedance on February 9, 2013 but for the presence of the natural events.

Section 7 contains conclusions that summarize the exceptional event that occurred on February 9, 2013, and relates the requirements in the EER to the information within this document.

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1. Exceptional Event Rule (EER) Requirements

In addition to the technical requirements that are contained within the EER, procedural requirements must also be met in order for EPA to concur with the flagged air quality monitoring data. This section of the document lays out the requirements of the EER and associated guidance, and discusses how the Kansas Department of Health and Environment (KDHE) addressed those requirements.

1.1 Procedural Requirements

This section presents a review of the procedural requirements of the EER as required by 40 CFR 50.14 (*Treatment of Air Quality Monitoring Data Influenced by Exceptional Events*) and explains how KDHE fulfills them. The Federal EER requirements include public notification that an event was occurring, the placement of informational flags on data in EPA's Air Quality System (AQS), the notification of EPA of the intent to flag through submission of initial event description, the documentation that the public comment process was followed, and the submittal of a demonstration supporting the exceptional events flag. KDHE has addressed all of these procedural and documentation requirements.

1.1.1 Public notification that event was occurring (40 CFR 50.14(c)(1(i))

The National Weather Service (NWS) office in Goodland, Kansas issued a Wind Advisory during the early morning of February 9, 2013. This Wind Advisory was subsequently upgraded to a High Wind Warning during the afternoon of February 9, 2013. Both the Wind Advisory and High Wind Warning advised the public that high winds will cause areas of blowing dust and reduced visibility. As a part of prior dust events across the state, KDHE has worked with the NWS offices and has developed additional health related language to add to their warning products. The additional language was implemented in NWS products in January of 2014 and is discussed in more detail in Appendix A. The Goodland NWS office forecast products that were issued on February 9, 2013, are included in Appendix B.

1.1.2 Place informational flag on data in AQS (40 CFR 50.14(c)(2)(ii))

KDHE submits data into EPA's AQS. Data from both filter-based and continuous monitors operated in Kansas are submitted to AQS.

When KDHE suspects that data may be influenced by an exceptional event, KDHE expedites analysis of the filters collected from the potentially-affected filter-based air monitoring instruments, quality assures the results and submits the data into AQS. KDHE also submits data from continuous monitors into AQS after quality assurance is complete.

If KDHE has determined a potential exists that the monitor reading has been influenced by an exceptional event, a preliminary flag is submitted for the measurement in the AQS. The data are not official until they undergo more thorough quality assurance and quality control,

leading to certification by May 1st of the year following the calendar year in which the data were collected (40 CFR 58.15(a)(2)). The presence of the flag can be confirmed in AQS.

1.1.3 Notify EPA of intent to flag through submission of initial event description by July of the calendar year following event (40 CFR 50.14(c)(2)(iii))

KDHE submitted a letter to EPA in July 2014 that KDHE intended to analyze under the Exceptional Events Rule an event that occurred on February 9, 2013. The exceedance event occurred at the Goodland monitoring site (20-181-001). This document serves as the demonstration supporting the flagging of this data.

1.1.4 Document that the public comment process was followed for event documentation (40 CFR 50.14(c)(3)(iv))

KDHE posted this document on the KDHE webpage for public review. KDHE opened a 30-day public comment period on December 10, 2015. A copy of the public notice, along with any comments received, will be submitted as part of this document, consistent with the requirements of 40 CFR 50.14(c)(3)(iv). See Appendix F for a copy of the public notice and comments.

1.1.5 Submit demonstration supporting exceptional event flag (40 CFR 50.14(a)(1-2))

At the close of the comment period, and after KDHE has had the opportunity to consider any comments submitted on this document, KDHE will submit this document, the comments received, and KDHE's responses to those comments to EPA Region VII headquarters in Lenexa, Kansas. The deadline for the submittal of this demonstration package is March 31, 2016.

Table 1-1. Kansas monitor with PM_{10} concentrations exceeding 150 µg/m^3 in 2013.

Monitor	AQS Site Code	Date in 2013	Observed 24-Hour Particulate Matter Concentration (µg/m^3)
Goodland (Sherman Co.)	20-181-0001	February 9	162

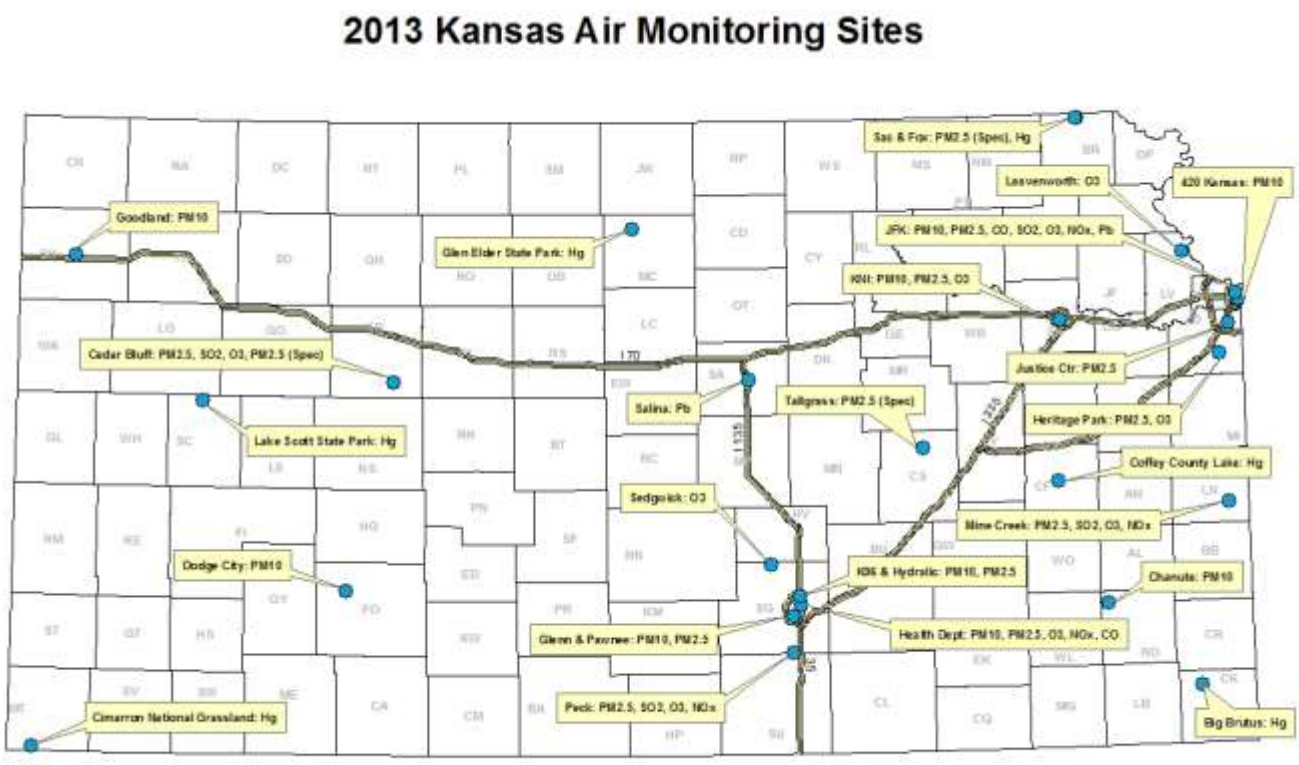


Figure 1-1. Kansas ambient air quality monitoring sites.

1.2 Documentation Requirements

Section 50.14(c)(3)(iii) of the EER states that in order to justify excluding air quality monitoring data, evidence must be provided for the following elements:

a. The event satisfies the criteria set forth in 40 CFR 501(j) that:

(1) the event affected air quality,

(2) the event was not reasonably controllable or preventable, and

(3) the event was caused by human activity unlikely to recur in a particular location or was a natural event;

b. There is a clear causal relationship between the measurement under consideration and the event;

c. The event is associated with a measured concentration in excess of normal historical fluctuations; and

d. There would have been no exceedance or violation but for the event.

Section 2 of this document introduces the conceptual model of the meteorological events that transpired on the days proceeding and the actual event on February 9, 2013, providing a background narrative of the exceptional event and an overall explanation that 'the event affected air quality. Further evidence that 'the event affected air quality' is provided in Section 5. Sections 2 and 5 also provide evidence that the event was a natural event.

Section 3 of this document provides data summaries and time series graphs which help illustrate that the event of February 9, 2013 produced PM_{10} concentrations in excess of normal historical fluctuations.

Section 4 of this document details the existing area agricultural control measures and demonstrates that despite the presence of these controls, the event of February 9, 2013 was not reasonably controllable or preventable.

Section 5 of this document establishes a clear causal connection between the natural event of February 9, 2013 and the exceedance of the 24-hour PM_{10} standard at the monitoring station. The evidence in this section (and the previous section on historical fluctuations) also confirms that the events in question both affected air quality and were the result of natural events.

Section 6 of this document builds upon the demonstration showing a clear causal connection between the natural event and the exceedances and concludes there would have been no exceedance on February 9, 2013 but for the presence of the natural events.

2. Conceptual Model

2.1 Geographic Setting and Climate

This section describes the geographic and climatic setting of the monitor.

2.1.1 Geographic Setting of Monitor

Sherman County is in the northwestern part of Kansas (Figure 2-1). It occupies 675,841 acres, or 1,055.99 square miles. A large part of the county occupies nearly level to gently sloping uplands. The highest point is about 8 miles south of Kanorado; the elevation is about 4,000 feet. Several points in the southeastern part of the county are at an elevation of about 3,000 feet. Goodland, the county seat, is located at 39°20′55″N 101°42′40″W (39.348583, -101.711148) at an elevation of 3,681 feet (1,122 m). The city of Goodland has a population of 4,554 and the Sherman County population is 6,110 (2014, Census Bureau). It lies on the south side of the Middle Fork of Sappa Creek, part of the Republican River watershed, in the High Plains region of the Great Plains. Located at the intersection of Interstate 70 and K-27 in northwest Kansas, Goodland is roughly 17 miles (27 km) east of the Colorado state line, 176 miles east-southeast of Denver, 265 miles (426 km) northwest of Wichita, and 383 miles (616 km) west of Kansas City. Agriculture is the most common industry in the county, providing 35.6% of employment. Other industries providing employment include professional, management, and administrative services (24.1%) and educational, health, and social services (13.6%). The breakdown of land mass is as follows: Agricultural Vegetation – 472,634 ac; Shrubland & Grassland – 177,318 ac; Developed & Other Human Use – 22,912 ac; Introduced & Semi Natural Vegetation – 1,907 ac; Forest & Woodland – 742 ac; Open Water – 160 ac; and Recently Disturbed or Modifiied – 160 ac.

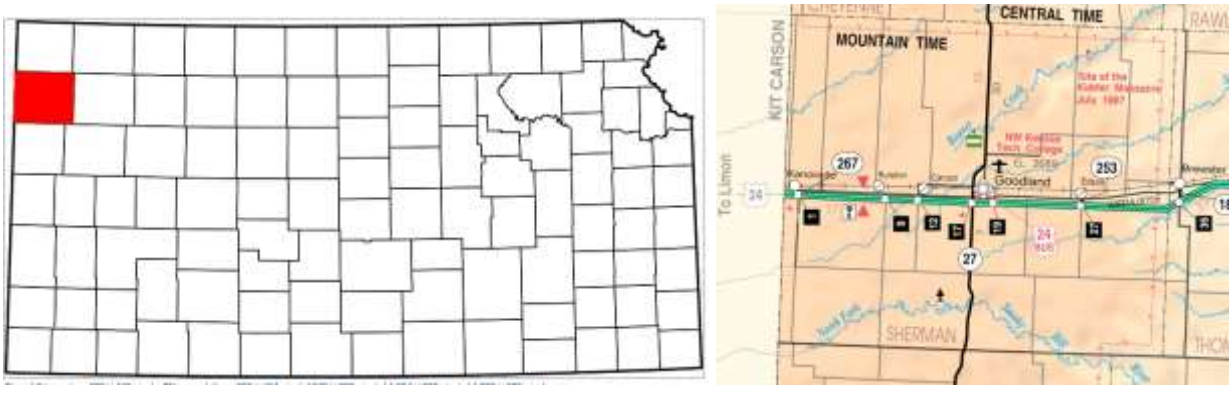


Figure 2-1. Location of Sherman County and Goodland, Kansas

2.1.2 Climate

Goodland has a semi-arid steppe climate with hot, dry summers and cold, dry winters. The average temperature for the year is 51.3 °F (10.7 °C) with temperatures exceeding 90 °F (32 °C) an average of 46 days a year and falling below 32 °F (0 °C) an average of 152 days a year. Due to its higher elevation, Goodland experiences stronger wind speeds and higher snowfall totals than other locations in Kansas. The yearly wind speed average is 12.1 mph (19.5 km/h). On average, Goodland receives 19.66 inches (499.4 mm) of precipitation annually, and snowfall averages 35.5 inches (90.2 cm) per year. On average, January is the coldest and driest month, with July being both the warmest and wettest month.

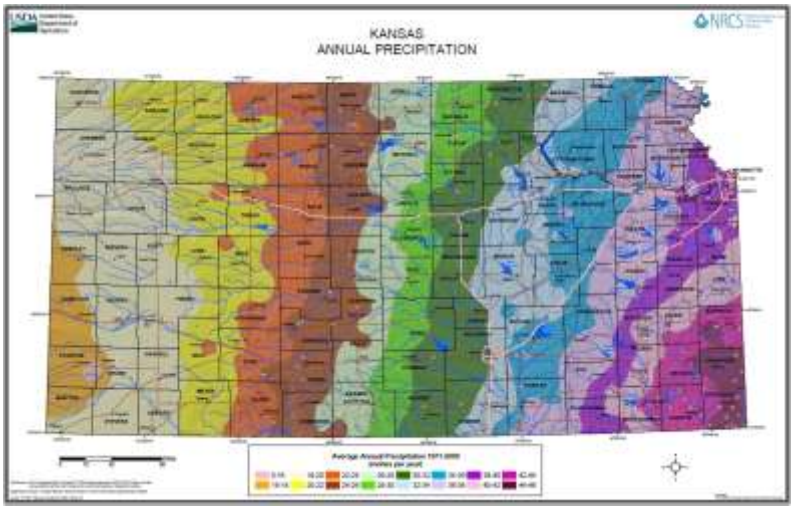


Figure 2-2. Kansas Annual Precipatation (USDA, NRCS)

Climate data for Goodland, Kansas

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record High °F (°C)	79 (26)	81 (27)	89 (32)	96 (36)	104 (40)	110 (43)	111 (44)	110 (43)	105 (41)	96 (36)	87 (31)	83 (28)	111 (44)
Normal High °F (°C)	42.4 (5.8)	45.3 (7.4)	54.6 (12.6)	63.6 (17.6)	73.0 (22.8)	83.9 (28.8)	90.0 (32.2)	87.5 (30.8)	79.1 (26.2)	66.2 (19.0)	52.4 (11.3)	42.5 (5.8)	65.0 (18.3)
Normal Mean °F (°C)	29.6 (−1.3)	32.3 (0.2)	40.5 (4.7)	49.2 (9.6)	59.4 (15.2)	69.7 (20.9)	75.7 (24.3)	73.7 (23.2)	64.6 (18.1)	51.9 (11.1)	39.0 (3.9)	29.9 (−1.2)	51.3 (10.7)
Normal Low °F (°C)	16.9 (−8.4)	19.4 (−7.0)	26.5 (−3.1)	34.7 (1.5)	45.8 (7.7)	55.6 (13.1)	61.3 (16.3)	60.0 (15.6)	50.1 (10.1)	37.5 (3.1)	25.7 (−3.5)	17.3 (−8.2)	37.6 (3.1)
Record Low °F (°C)	−26 (−32)	−22 (−30)	−20 (−29)	0 (−18)	21 (−6)	31 (−1)	42 (6)	38 (3)	19 (−7)	7 (−14)	−12 (−24)	−27 (−33)	−27 (−33)
Normal Total Precipitation Inches (mm)	0.38 (9.65)	0.49 (12.5)	1.07 (27.2)	1.59 (40.4)	2.95 (74.9)	3.25 (82.6)	3.47 (88.1)	2.70 (68.6)	1.22 (31.0)	1.37 (34.8)	0.71 (18.0)	0.46 (11.7)	19.66 (499.4)
Normal Snowfall Inches (cm)	5.9 (15.0)	5.4 (13.7)	6.8 (17.3)	4.2 (10.7)	0.5 (1.3)	0 (0)	0 (0)	0 (0)	0.4 (1.0)	2.2 (5.6)	4.6 (11.7)	5.5 (14.0)	35.5 (90.2)
Mean Wind Speed MPH (Km/h)	11.9 (19.2)	12.2 (19.6)	13.4 (21.6)	14.1 (22.7)	13.1 (21.1)	12.3 (19.8)	11.3 (18.2)	10.7 (17.2)	11.5 (18.5)	11.8 (19.0)	11.9 (19.2)	11.7 (18.2)	12.1 (19.5)

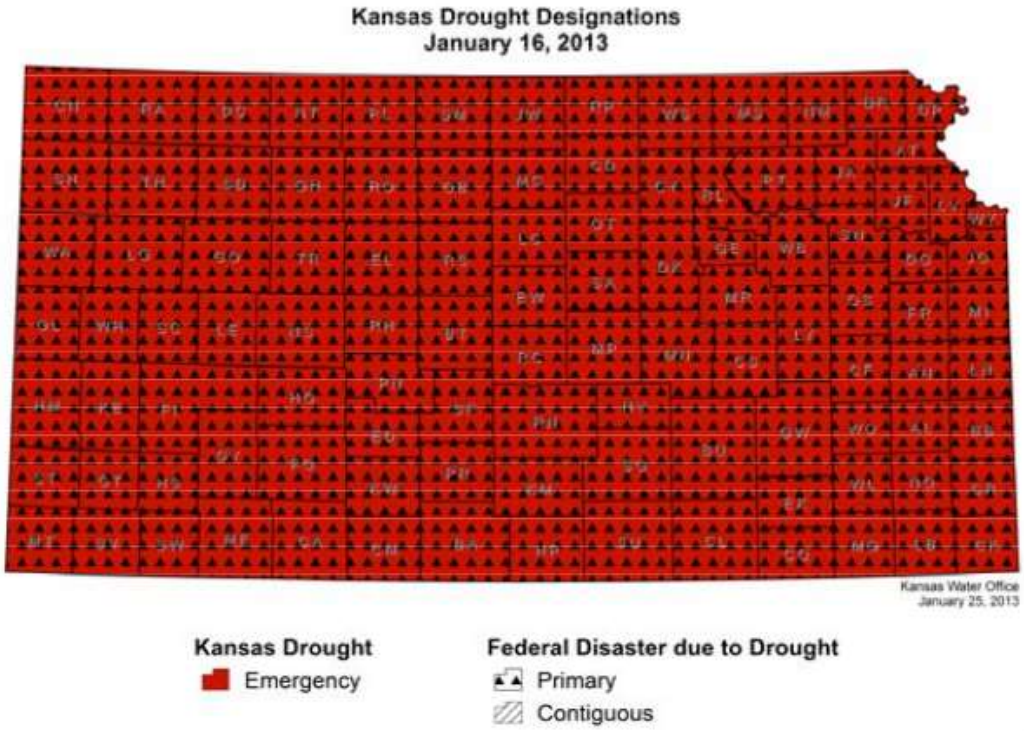
Source: National Weather Service

Figure 2-3. Climatology data for Goodland, Kansas (NWS)

In addition to the typical wind speeds, which as noted above are already higher than most other areas of Kansas, strong storm systems that move through the area (typically from the west) can lead to even higher wind speeds and result in blowing dust. Such strong systems and their associated pressure differences and frontal boundaries can make determining specific source areas difficult as they can transport dust and other particulates vast distances, often over multiple potential source areas.

An important factor in the blowing dust was ongoing long term drought not only across the area, but the entire region. The State of Kansas had previously declared an Emergency Drought

Designation across the entire state (Figure 2-4). The U.S. Drought Monitor update issued shortly after this dust event shows much of western Kansas (Figure 2-5), western Nebraska and eastern



Colorado (Figure 2-6), as well as eastern New Mexico and the Oklahoma/Texas Panhandles (Figure 2-7) in D3 (Extreme) to D4 (Exceptional) drought. It is also noted in the drought impacts (Figure 2-7) that this drought was considered both short and long term affecting agriculture, grasslands, hydrology, and ecology. Rainfall across Northwest Kansas was a mere 53% of normal from September 1, 2012 to February 14, 2013 (Figure 2-8). Such abnormally dry conditions resulted in a large area of soils that were vulnerable to particulate suspension. As will be discussed in other sections of this document, these areas of drought are all potential source regions for the dust event that occurred on February 9, 2013.

Figure 2-4. Kansas Drought Designations, January 16, 2013

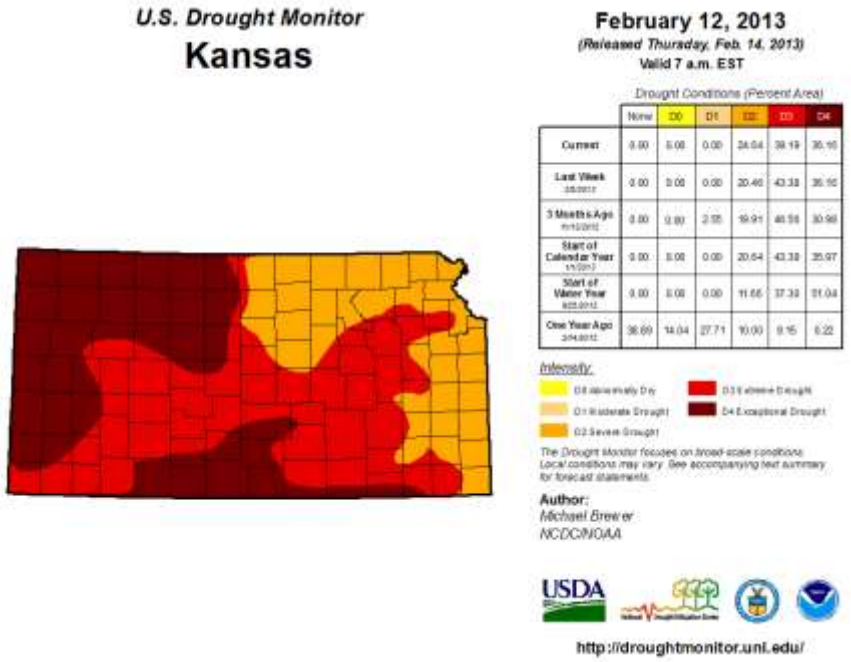


Figure 2-5. U.S. Drought Monitor Data for Kansas February 12, 2013 (USDA)

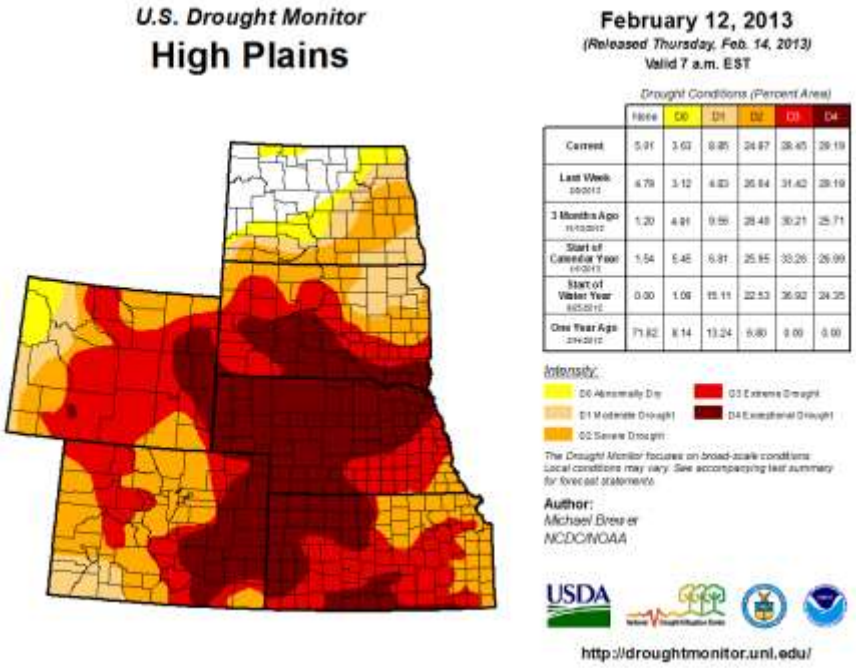


Figure 2-6. U.S. Drought Monitor Data for the High Plains February 12, 2013 (USDA)

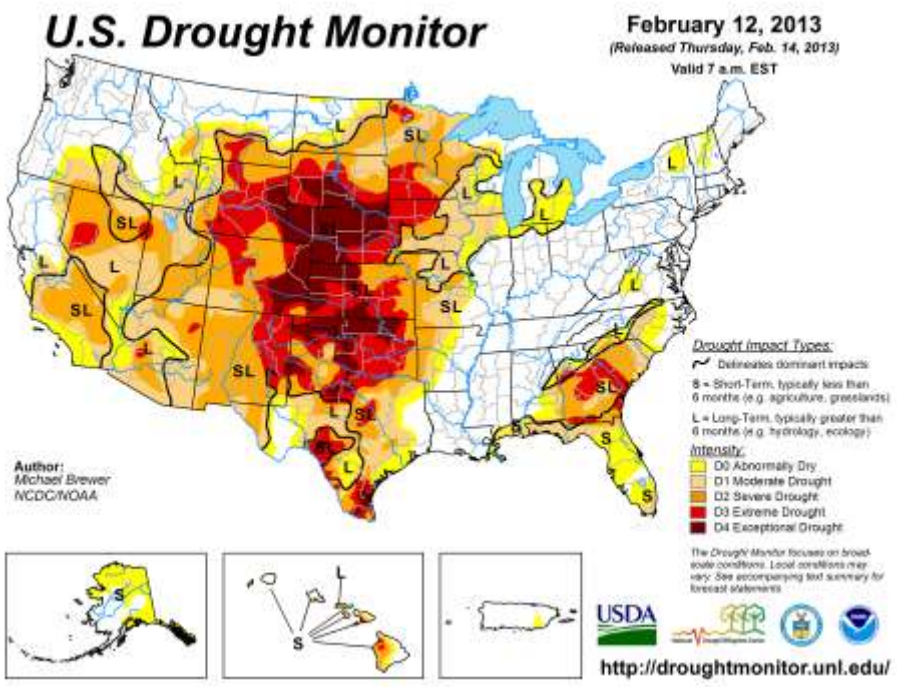


Figure 2-7. U.S. Drought Monitor Data & Impacts February 12, 2013 (USDA)

Kansas Climate Division Precipitation Summary (inches)												
Climate Division	February 1 to February 14			January 1 to February 14			April 1 to February 14			September 1 to February 14		
	Actual	Normal	Percent Normal	Actual	Normal	Percent Normal	Actual	Normal	Percent Normal	Actual	Normal	Percent Normal
Northwest	0.15	0.23	69	0.38	0.68	58	10.97	19.68	55	2.73	5.09	53
West Central	0.03	0.27	12	0.32	0.77	42	10.28	18.98	53	3.01	5.18	57
Southwest	0.01	0.26	2	0.50	0.73	69	12.20	18.20	66	4.2	5.12	82
North Central	0.14	0.38	31	1.17	1.01	112	17.12	25.47	66	5.31	7.64	69
Central	0.66	0.47	127	1.57	1.17	131	16.59	26.42	62	5.37	7.89	67
South Central	0.27	0.53	48	0.94	1.36	70	15.70	27.97	56	4.28	9.12	47
Northeast	0.26	0.51	46	1.02	1.32	74	19.21	32.01	60	6.15	10.53	58
East Central	0.67	0.60	111	1.57	1.54	98	18.96	34.43	55	7.73	11.73	64
Southeast	0.70	0.77	89	2.58	2.02	122	24.79	37.41	65	9.79	13.98	68
STATE	0.32	0.45	58	1.14	1.19	87	16.23	26.64	60	5.43	8.48	63
Note: 1971-2000 normal value, 100 percent =normal Source: KSU Weather Data Library												

Figure 2-8. Kansas Climate Division Precipitation Summary, February 2013

2.2 Event Summary

To analyze the specific conditions on the days leading up to and including the day when the 24-hour PM_{10} concentrations exceeded the standard (162 µg/m^3) at the Goodland monitoring station on February 9, 2013, air quality and meteorological data were first collected from a wide variety of sources (Table 2-1). These sources were selected because of their high standards for data quality. Additional meteorological parameters, such as vector average winds and daily maximum temperatures, were calculated as necessary. Table 2-2 describes why these data are needed to understand and explain the processes that may lead to dust event conditions.

Table 2-1. Data types and sources used in the Exceptional Events analysis.

Type of Data	Source(s)	Location(s)	Date Range
Air Quality Data: 1-hour PM_{10} 24-hour PM_{10}	KDHE	Kansas air quality monitors	Jan. through Dec., 2009-2013
Surface meteorological data (METAR[a])	National Weather Service (NWS), Kansas Mesonet	All available Kansas sites and surrounding states sites	Jan. through Dec., 2009-2013
Upper-air meteorological data (radiosonde)	National Weather Service (NWS)	Dodge City, KS (KDDC) Norman, OK (KOUN)	February 2013
Surface and upper-level weather maps	NWS, Plymouth Weather Center, Hydrometeorological Prediction Center	National and Regional	February 2013
Visible and infrared satellite imagery	National Weather Service (NWS)	National	February 2013
Daily MODIS[b] Visible satellite imagery	SSEC[c]	National	February 2013

[a] Meteorological Terminal Aviation Routine Weather Report
[b] Moderate Resolution Imaging Spectroradiometer
[c] Space Science and Engineering Center, University of Wisconsin-Madison

Table 2-2. Description of processes that influence particulate levels.

Type of Data	Relation to Particulate Levels
Surface wind speeds	Surface wind data were used to assess pollutant dispersion. Strong winds can result in higher PM levels in the atmosphere.
Trajectories (HYSPLIT[a])	Trajectory analysis was used to assess transport of pollutants. Air parcels originating in or passing through regions of higher pollution levels (e.g., dust) indicate potential transport of pollutants to downwind locations.
Upper-air soundings	Soundings were used to assess atmospheric stability (and inversions) and the likelihood that dust would remain in the lower levels of the atmosphere as opposed to being mixed into aloft layers. Confirming that the dust would most likely remain in the lower layers of the atmosphere also provides guidance on which trajectory levels are appropriate to assess dust transport.

Upper-level weather maps	500 mb weather maps were used to determine the locations of upper-level ridges and troughs.
Surface weather maps	Surface weather maps were used to determine the positions of high- and low-pressure systems and surface frontal boundaries in relation to the impacted monitors. These meteorological features are the primary drivers of surface wind speed and direction, and thus of pollutant dispersion and transport.
Satellite imagery	Satellite imagery was used to assess potential dust at the impacted monitors.
PM_{10} and visibility	Particle concentrations from air quality monitors and visibility observations from surface meteorological data were collected to assess the presence of dust at air quality monitors.

[a] Hybrid Single Particle Lagrangian Integrated Trajectory Model

High winds can entrain and transport particulate matter (PM) to a monitoring site. These particles can consist of both PM_{10} (i.e., particles less than or equal to 10 micrometers (µm) in diameter) and $PM_{2.5}$ (i.e., particles less than 2.5 µm in diameter). High wind dust events can include both PM_{10} and $PM_{2.5}$. A swift moving storm system impacted the area during the February 8-9, 2013 period which resulted in strong southerly winds across Kansas and the surrounding region.

2.2.1 February 8, 2013

On February 8, 2013, a large upper level low and associated trough of lower pressures was observed during the 12z Febrary 8, 2013 (5a.m. MST February 8, 2013) 500-mb analysis along the West Coast as shown in Figure 2-9. At the surface (Figure 2-10), a deepening low pressure system was located over southern Nevada with a departing low pressure system near Ohio. Between the two areas of low pressure relatively tranquil weather was observed over much of Kansas and the Plains with wind speeds less than 15 mph at 5a.m. February 8, 2013. However, the progression of the trough and low pressure over Nevada was quick to the east resulting in increased winds, sustained at nearly 30 knots (35 mph) from northeast New Mexico through western Kansas by 11a.m. February 8, 2013 as shown by Figure 2-11.

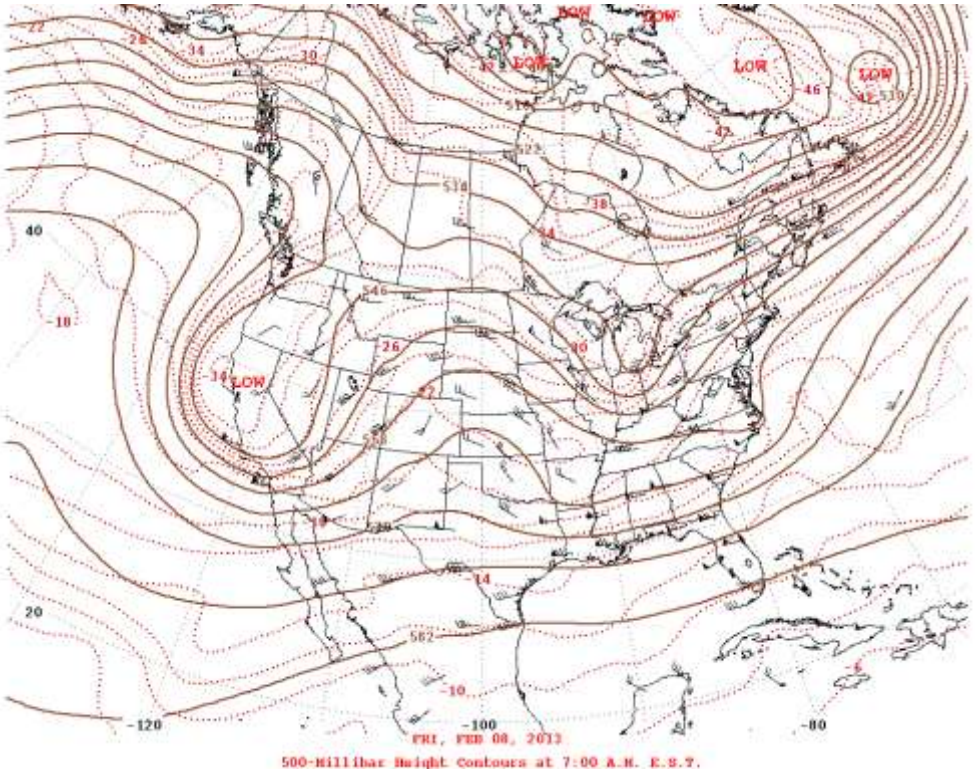


Figure 2-9. 500mb Analysis for 12Z February 8, 2013
(5a.m. MST February 8, 2013) (Hydrometeorological Prediction Center)

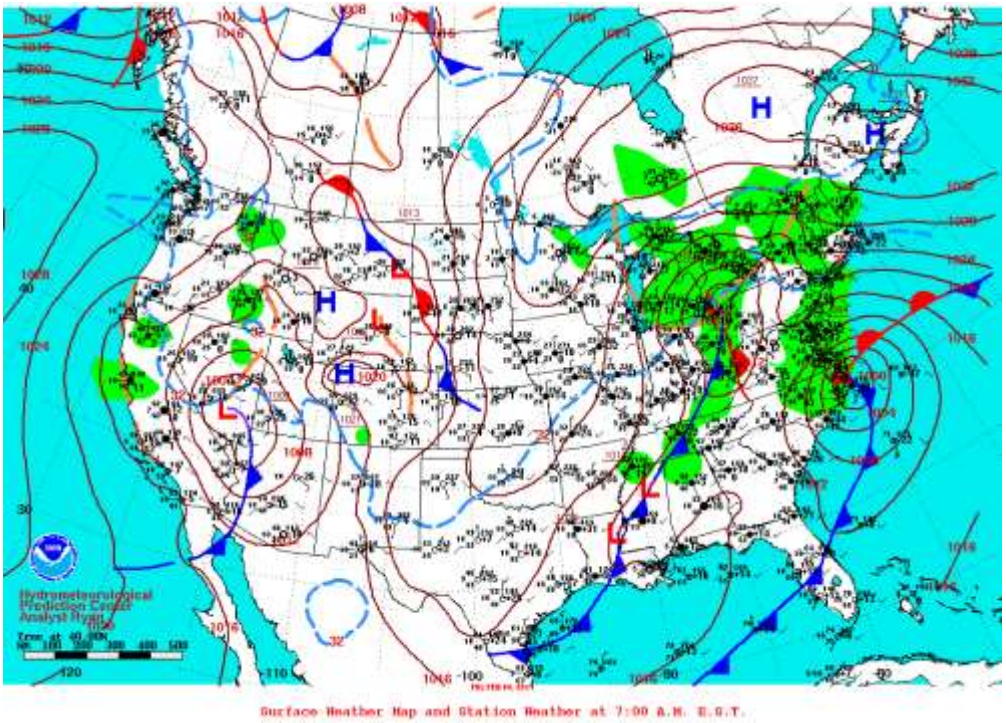


Figure 2-10. Surface Analysis for 12Z February 8, 2013
(5a.m. MST February 8, 2013) (Hydrometeorological Prediction Center)

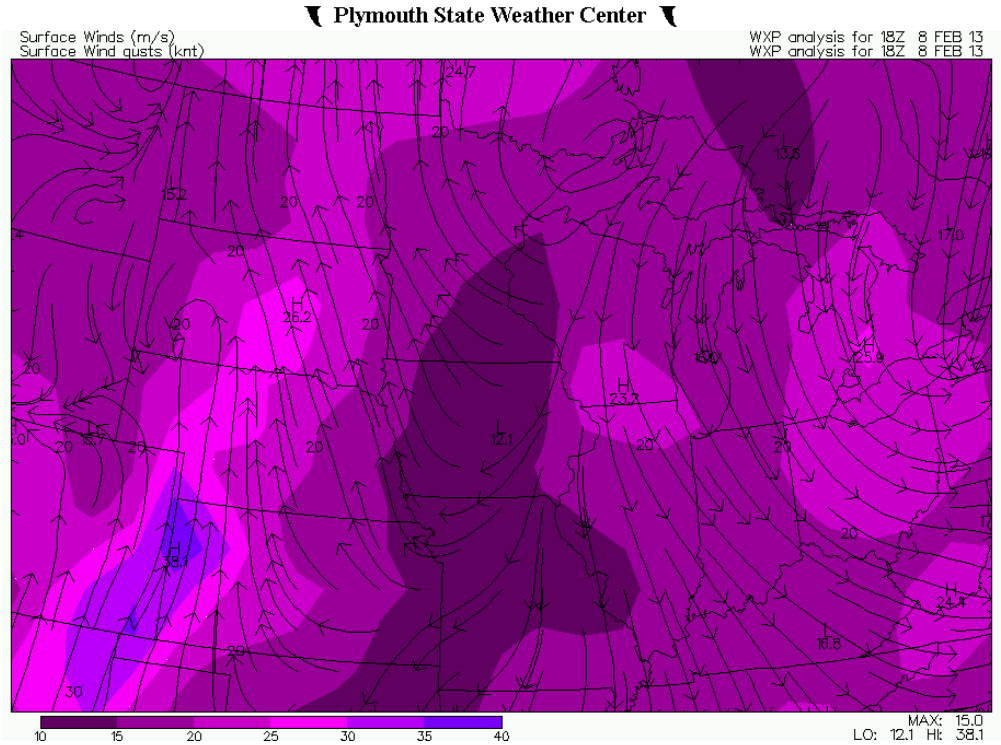


Figure 2-11. Surface Wind Speeds (knots) and Streamlines for 18Z February 8, 2013 (11a.m. MST February 8, 2013) (Plymouth State Weather Center)

2.2.2 February 9, 2013

On February 9, 2013, the Goodland, Kansas air monitoring site recorded an exceedance of the 24-hour PM_{10} standard with a concentration of 162 µg/m^3. The Goodland monitoring site is located on the roof of the Goodland fire station near downtown and is a filter based monitoring instrument (Figure 2-12). The exceedance at Goodland and elevated readings at other monitoring locations were the consequence of a strong, compact surface low pressure system and associated frontal boundaries causing strong gusty winds. Combined with long-term drought conditions across the region which caused significant suspended particulate matter.

Figure 2-12. Goodland, KS PM_{10} Monitoring site location (Google Earth)

Two areas of low pressure were analyzed at the surface 12Z February 9, 2013 (5a.m. MST February 9, 2013) with a cold front located northwest of Kansas (Figure 2-13). Surface analysis at 12Z February 10, 2013 (5a.m. MST February 10, 2013) shows the surface low pressure had deepened from 1000-millibar to 992-millibar during the course of the 24 hour period during the exceedance (Figure 2-14). The center of the surface low pressure likely passed just north of Goodland, Kansas on February 9, 2013 given the track shown by the two surface analysis. An occluded front and secondary cold front both passed through Goodland during the evening and overnight hours of Febraury 9-10, 2013.

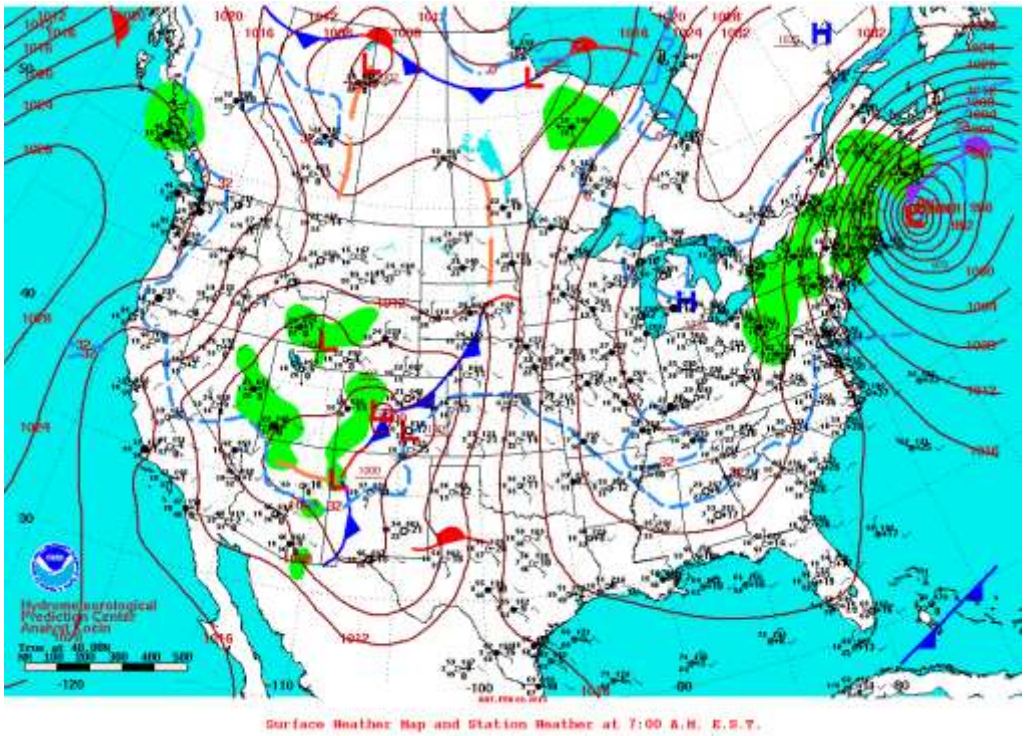


Figure 2-13. Surface analysis for 12Z February 9, 2013
(5a.m. MST February 9, 2013) (Hydrometeorological Prediction Center)

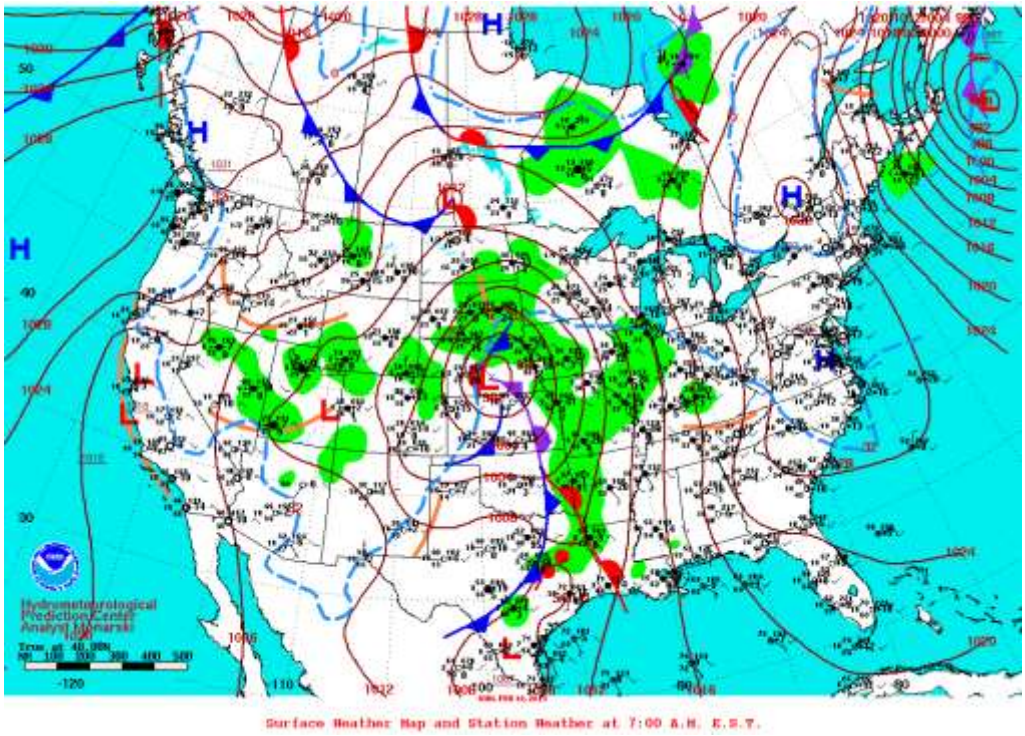


Figure 2-14. Surface analysis for 12Z February 10, 2013
(5a.m. MST February 10, 2013) (Hydrometeorological Prediction Center)

These surface features were assocated with a deepening area of low pressure throughout the atmosphere, signifying a strengthening storm system at all levels. 500-millibar analysis at 12z February 9, 2013 (5a.m. MST February 9, 2013) shows a height of 540 decameters with upper level winds at 100 knots at the base of the trough over Arizona (Figure 2-15). Analysis of 500-millibars at 12z February 10, 2013 (5a.m. MST February 10, 2013) shows the center of low pressure now over Nebraska with a height of 534 decameters, and upper level winds of 90-105 knots over Kansas and Oklahoma in the base of the trough, south of the center of low pressure (Figure 2-16).

The combination of such surface and upper level features created strong winds at the surface during the day of February 9, 2013, primarily from the south across Kansas before the passing of the occluded and cold fronts. Sustained wind speeds at or above 20 knots (23 mph) are shown by 18z February 9, 2013 (11a.m. MST February 9, 2013) over western Kansas in Figure 2-17 with surface wind gusts exceeding 30 knots (35 mph) over western Kansas as well (Figure 2-18). Surface winds begin to subside by 00z February 10, 2013 (5p.m. MST February 9, 2013) and begin to become more southeasterly as the center of the surface low passed by to the north, and the occluded boundary approached the Goodland area as shown by the streamlines in Figure 2-19. The strongest winds at the surface throughout the day were just south of the Goodland area across western Kansas, the Oklahoma and Texas panhandles, and eastern New Mexico.

The National Weather Service offices across the region, including Goodland, KS, Dodge City, KS, Amarillo, TX, Lubbock, TX, Pueblo, CO and Boulder, CO all issued products that included mention of strong winds. Such products included were Wind Advisories and a High Wind Warning (Figure 2-20) and a Short Term Forecast (Figure 2-21) for the Goodland, KS area that specifically mentioned blowing dust as an impact. Full text of all regional NWS products from February 9, 2013 can be found in Appendix B.

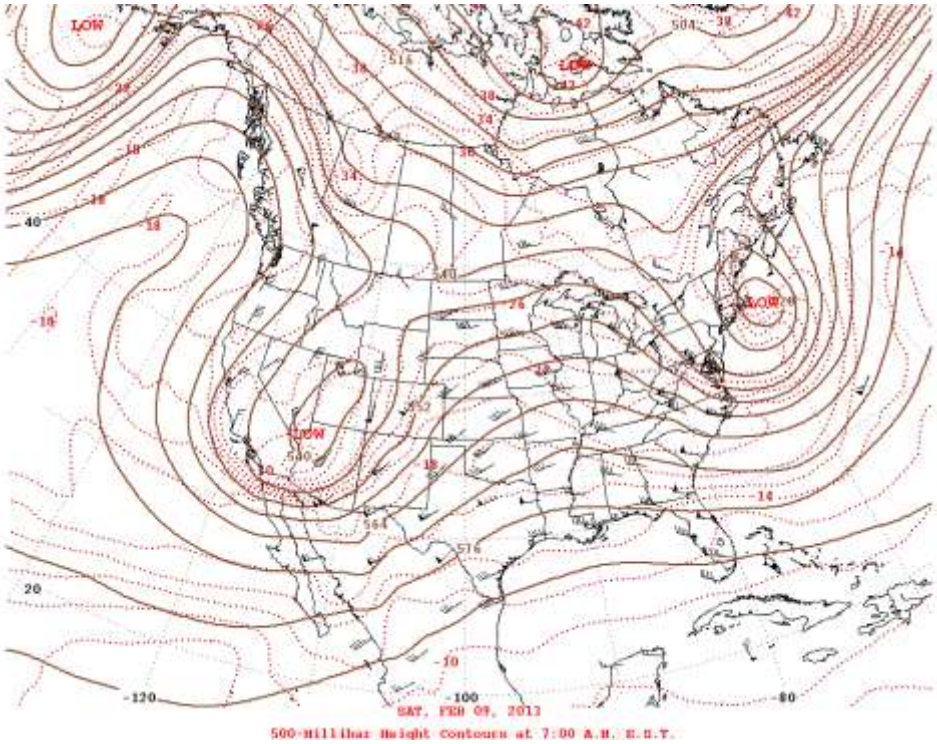


Figure 2-15. 500mb Analysis for 12Z February 9, 2013
(5a.m. MST February 9, 2013) (Hydrometeorological Prediction Center)

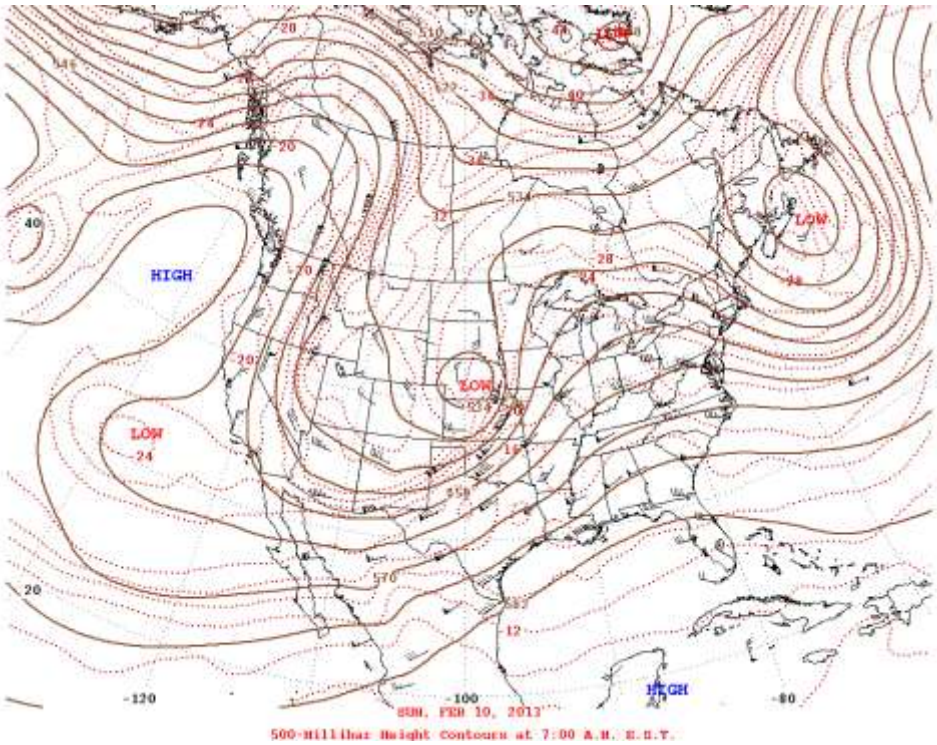


Figure 2-16. 500mb Analysis for 12Z February 10, 2013
(5a.m. MST February 10, 2013) (Hydrometeorological Prediction Center)

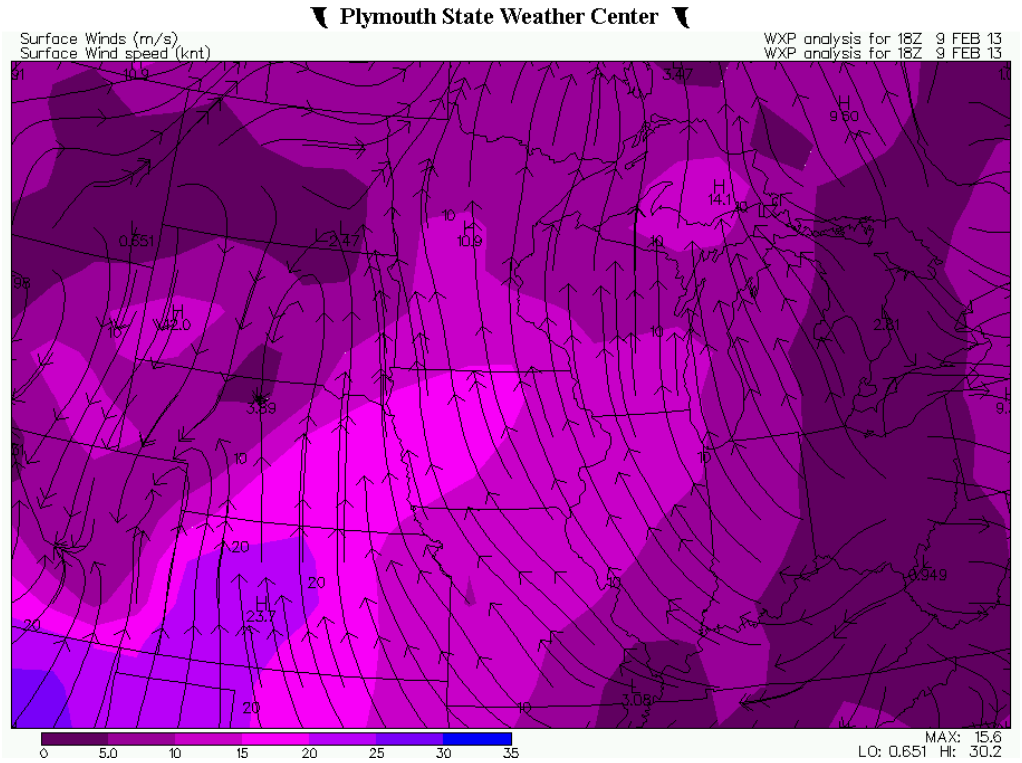


Figure 2-17. Surface Wind Speeds (knots) and Streamlines for 18Z February 9, 2013 (11a.m. MST February 9, 2013) (Plymouth State Weather Center)

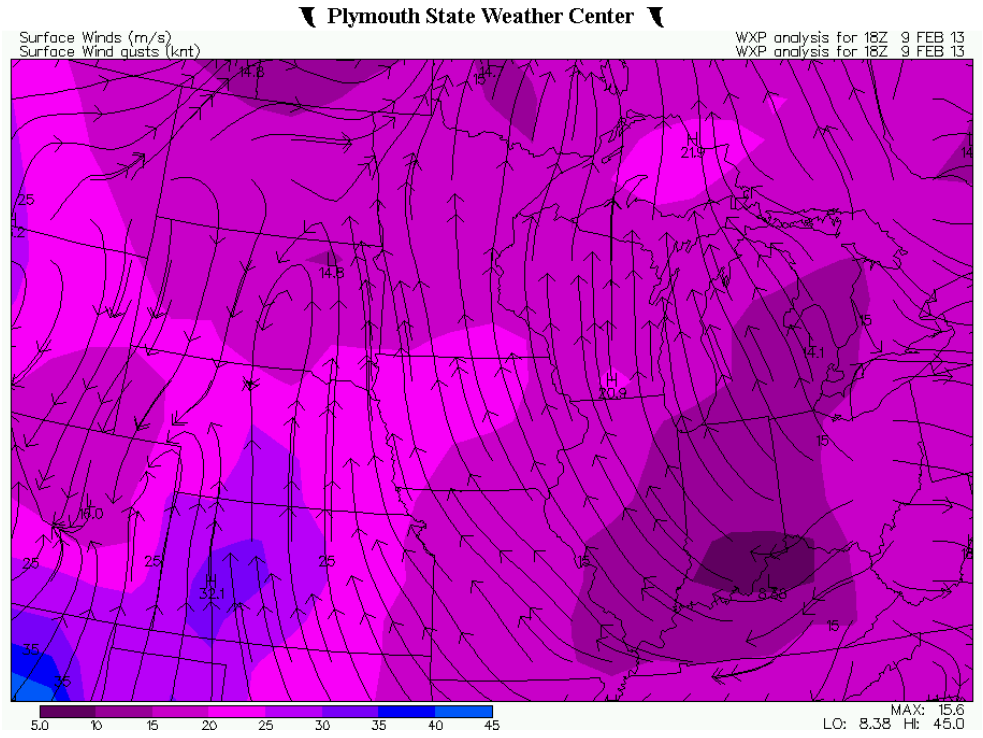


Figure 2-18. Surface Wind Speed Gusts (knots) and Streamlines for 18Z February 9, 2013 (11a.m. MST February 9, 2013) (Plymouth State Weather Center)

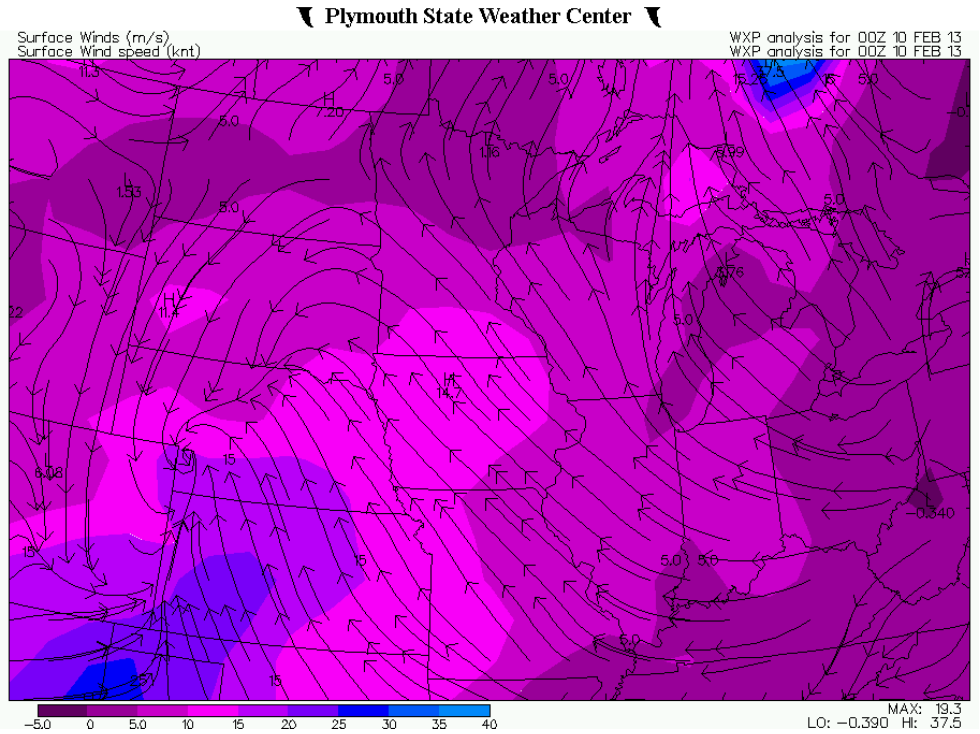


Figure 2-19. Surface Wind Speeds (knots) and Streamlines for 00Z February 10, 2013 (5p.m. MST February 9, 2013) (Plymouth State Weather Center)

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GOODLAND KS
433 PM MST SAT FEB 9 2013

...WINDY CONDITIONS TODAY AND INTO THIS EVENING...

...HIGH WIND WARNING IN EFFECT UNTIL 7 PM MST THIS EVENING...
...HIGH WIND WATCH REMAINS IN EFFECT FROM LATE TONIGHT THROUGH SUNDAY AFTERNOON...

THE NATIONAL WEATHER SERVICE IN GOODLAND HAS ISSUED A HIGH WIND WARNING...WHICH IS IN EFFECT UNTIL 7 PM MST THIS EVENING. THE WIND ADVISORY IS NO LONGER IN EFFECT.

* TIMING/DURATION...STRONG WINDS WILL OVERSPREAD THE AREA OVER THE NEXT HOUR.

* PEAK WINDS...SUDDEN WIND GUSTS TO 65 MPH ARE EXPECTED.

* OTHER IMPACTS...BLOWING DUST WILL SEVERELY RESTRICT VISIBILITY IN SOME AREAS AS THE WINDS MOVE INTO THE AREA. THIS AREA OF DUST AND WINDS WILL IMPACT INTERSTATE 70.

Figure 2-20. High Wind Warning issued by Goodland NWS 4:33p.m. MST February 9, 2013

```
SHORT TERM FORECAST
NATIONAL WEATHER SERVICE GOODLAND KS
411 PM MST SAT FEB 9 2013

COZ091-092-KSZ013-027-041-100015-
CHEYENNE COUNTY CO-KIT CARSON COUNTY CO-SHERMAN KS-GREELEY KS-
WALLACE KS-
411 PM MST SAT FEB 9 2013

.NOW...

STRONG SOUTHERLY WINDS GUSTING TO 50 MPH WILL CONTINUE THROUGH 515
PM MST AND MAY BE LOCALLY ENHANCED BY WEAK SHOWERS MOVING OVER THE
AREA. BLOWING DUST WILL ACCOMPANY THESE WINDS...REDUCING VISIBILITY
TO UNDER A MILE AT TIMES. THOSE TRAVELING ON INTERSTATE 70 BETWEEN
GOODLAND AND STRATTON SHOULD BE READY FOR PERIODS OF CHANGING
VISIBILITY.
```

Figure 2-21. Short Term Forecast issued by Goodland NWS 4:11p.m. MST February 9, 2013

2.3 Conclusions

This Conceptual Model was created to provide a basic description of the meteorological conditions that led to suspended particulate matter on February 9, 2013 and the PM_{10} exceedance in Sherman County (Goodland). A more detailed analysis of the event is included in Section 5, where a demonstration of the clear causal connection between uncontrollable natural events and the PM_{10} exceedance day is presented.

3. Historical Fluctuations

The PM_{10} concentration measured in Sherman County at the Goodland monitoring site during February 9, 2013 was the highest 24-hour average measured over the course of a five year period (2009-2013) at that monitor site. A time series plot of the 24-hour average PM_{10} concentrations for the five yea period was created (Figure 3-1) with the exceedance of February 9, 2013 displayed as a red marker, with the remaining days using blue markers.

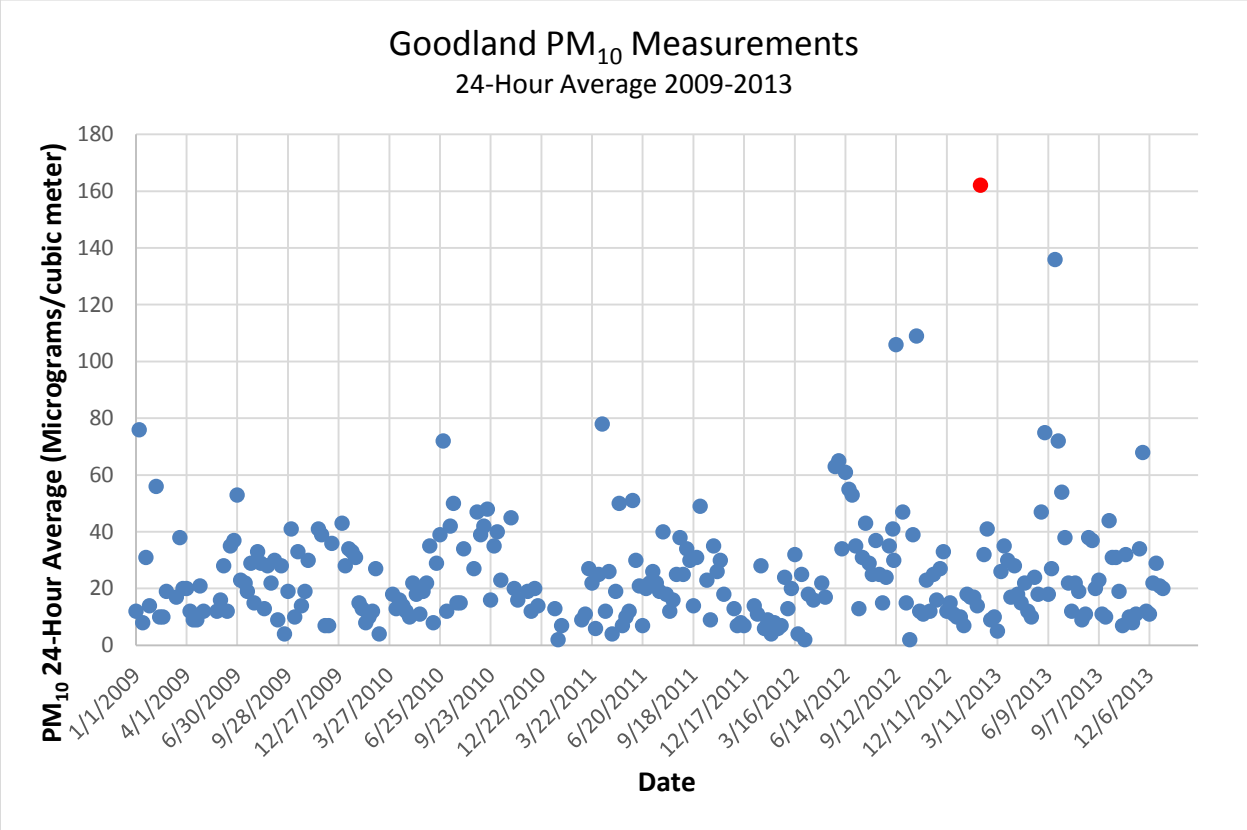


Figure 3-1. 24-hour average PM_{10} concentrations (2009-2013) at Goodland Monitoring Site

Over the course of the five year period of 2009-2013 the average/mean concentration recorded at the Goodland monitoring site is 25.1 µg/m^3 with a standard deviation of 19.7 µg/m3. The maximum of 162 µg/m^3 recorded on February 9, 2013 was nearly 7 standard deviations above the mean, and undoubtably a large outlier. Table 3-1 below shows a summary of the data from the Goodland monitoring site during the five year period.

Table 3-1. Goodland PM_{10} Monitoring Data Summary (2009-2013)

	Goodland PM_{10}
Mean	25.1
Median	20
Mode	12
sd	19.7
Variance	388.2
Minimum	2
Maximum	162
Count	268

The spatial scope of this event, as with most particulate matter events, is somewhat difficult to discern due to sparse observations. This event also complicates matters with its timing across the region, while not lasting more than 24 hours in any one location, it does span two or more calendar days across the region. A look at data from PM_{10} monitors across Kansas and the region in Table 3-2 shows two exceedances, one at Goodland on Feburary 9, 2013 and another near Lamar, CO on February 8, 2013. As will be discussed in other sections of this document, HYSPLIT trajectories from Goodland will show the air mass, and hence particulate matter, from Lamar, CO was transported towards Goodland during this exceedance event. While other Kansas monitors remained well below standard many saw a large increase in particulate matter on February 10, 2013 as the surface frontal boundary and likely suspended particulate matter moved through those areas as well

Table 3-2. Regional 24-hour and 1-hour PM_{10} readings for February 8-10, 2013

	February 8, 2013		February 9, 2013		February 10, 2013	
Site	24 hour Maximum	1 hour Maximum	24 hour Maximum	1 hour Maximum	24 hour Maximum	1 hour Maximum
Dodge City	4.7	10	8.6	17	11.5	30
Chanute			14			
Glenn & Pawnee	11.0	23	8.7	11	15.5	51
Wichita HD	8.0	14	7.6	12	14.5	43
K96 & Hydraulic	11.5	19	11.1	14	20.2	87
KNI	3.1	16	4.7	15	7.9	17
Goodland			**162**			
Gothenburg, NE			22			
Cozad, NE			24			
Lamar, CO	159		73		27	

The approximate percentile values that the exceedance on February 9, 2013 at Goodland represents for the five year period, for the month of the event (all samples in February during the five year period), and the year of the event are shown in Table 3-3. This event represents the 100th percentile in all time periods.

Table 3-3. Percentile Values for February 9, 2013 PM_{10} Concentration in Goodland (2009-2013 Data)

Time Period	Goodland
February 9, 2013	162 µg/m^3
Overall	1.00
All February	1.00
2013	1.00

Data from the Goodland monitoring site over the five year period was summarized by month and year. The summary (Table 3-4) shows slightly higher monthly averages during the June-October period, while the remainder of months all remain below 25 µg/m^3; note PM_{10} levels do not necessarily fluctuate by season but rather are influenced greatly by local sources on a day-to-day basis. Such local sources include regional agriculture activities, vehicle contributions via road dust, and road sanding/sweeping. The time frame of slightly higher monthly averages also coincides with periods of meteorological warmth and dryness, with periodic heat waves and short-term drought. With a conservative approach a normal value should be no higher than the historic monthly 75th percentile, which for February during this event equates to 48 µg/m^3.

Table 3-4. Monthly PM_{10} Monitoring Data Summary for Goodland Monitor

Site	Goodland (2009-2013)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mean	20.4	24.24	19.1	18.5	20.5	40.9	28.5	25.7	31.0	27.0	24.3	15.9
Median	14	12	20	16	17	35	22	25	30	23	20	12
Mode	31	10	20	12	12	35	22	25	30	10	30	7
St. Dev.	16.0	35.0	10.6	14.2	14.4	27.1	14.5	9.8	20.1	21.3	13.9	8.8
Variance	256.9	1222.6	111.5	200.8	206.5	731.6	208.8	96.5	405.5	454.4	193.2	76.9
Minimum	2	4	4	2	7	7	12	9	4	2	8	7
Maximum	76	162	38	78	63	136	72	47	106	109	68	36
Count	23	19	20	23	21	25	26	25	25	23	19	19

Comparing data from the month of February over the five year period, and 2013 with and without the Feburary 9, 2013 event is shown in Table 3-5. Removing this event from February data results in a 8.5 µg/m^3 drop in the mean, and other significant drops in standard deviation and variance. Dropping this event from 2013 results in a 2.7 µg/m^3 drop in the yearly mean.

Table 3-5. Month and Year Goodland PM_{10} Monitoring Data Summary

Site	Goodland			
	February (with 02/09/2013 data)	February (w/o 02/09/2013 data)	2013 (with 02/09/2013 data)	2013 (w/o 02/09/2013 data)
Mean	24.2	15.7	28.0	25.3
Median	12	10	20	20
Mode	10	10	10	10
sd	35.0	13.47	27.2	21.2
Variance	1222.6	181.48	737.4	448.9
Minimum	4	0	5	0
Maximum	162	56	162	136
Count	19	19	61	61

Figure 3-2 shows the frequency histogram from the Goodland PM_{10} monitor during the five year period. A large portion (over 92%) of the samples are values less than 50 µg/m^3 and nearly 99% of the samples are less than 80 µg/m^3.

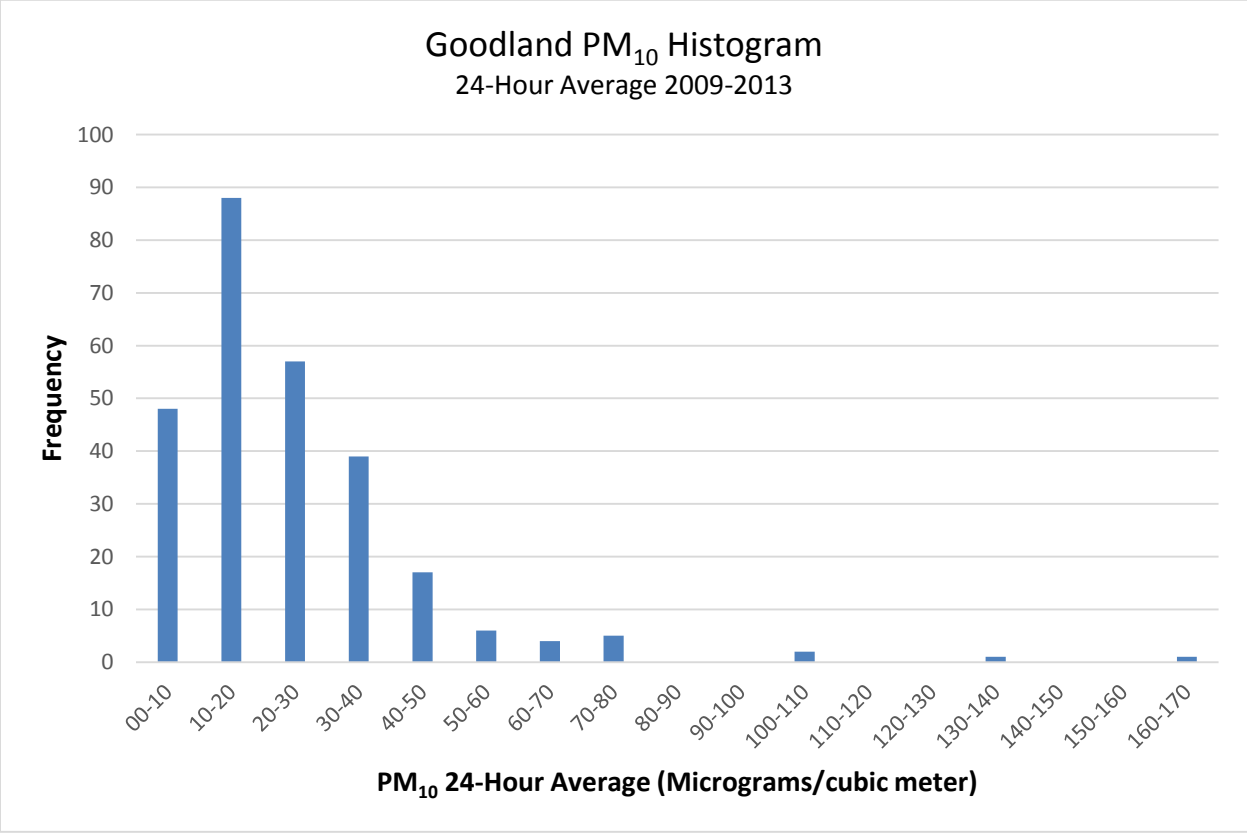


Figure 3-2. PM_{10} Histogram (2009-2013) at Goodland Monitoring Site

4. Not Reasonably Controllable or Preventable

Section 50.1(j) of Title 40 CFR Part 50 requires that an event must be "not reasonably controllable or preventable" in order to be defined as an exceptional event. This requirement is met by demonstrating that despite reasonable agricultural control measures in place within Sherman County and the Goodland area, high wind conditions overwhelmed all reasonably available controls. The event occurring on February 9, 2013 was directly related to strong and gusty winds generated by an intensifying low pressure system and its accompanying frontal boundaries. The strong winds overwhelmed all reasonably available controls, and were also responsible for transporting particulate matter into the Goodland area from areas outside of the region. As explained in the conceptual model, the strong and gusty winds, in tandem with long term drought conditions across the region lead to areas of airborn particulate matter, primarily dust, across the Goodland and surrounding area. As shown in Section 5, the source region for this event and the associated transported dust on February 9, 2013, came from areas outside of the Goodland area; primarily from southeast Colorado and eastern New Mexico. While it is likely that dust was generated within the Goodland area as strong winds and gusts from the low pressure system and its cold front passed through the area, the amount of dust generated locally was easily overwhelmed by, and largely unnoticeable as compared to the dust transported in from the source regions. Controls on local agricultural sources of fugitive dust were in place and implemented during the event of February 9, 2013, but were not capable of controlling transported dust (PM_{10}) raised by the gusty and turbulent winds on this date.

The following section describe the Best Available Control Measures (BACM) in place during the event of February 9, 2013. The Goodland monitor has never violated the PM_{10} standard so the area is currently in attainment for the PM_{10} NAAQS. There are therefore no stringent PM_{10} regulations in place in Goodland, Sherman County or the region around the monitoring site. There is only one regulated point source located in the county and it produces under 6 tons of PM_{10} per year.[1] Inspections of local potential sources performed before, during and after the event of February 9, 2013, confirmed that no unusual anthropogenic PM_{10} producing activities occurred in Sherman County, the Goodland area, nor the local areas surrounding the exceeding monitor.

The following have been identified as potential sources of blowing dust during high wind events in Kansas.

a) Tilled agricultural land;
b) sparsely vegetated or overgrazed range land;
c) unpaved roads and parking lots;
d) urban paved roads; and
e) construction sites

The following have been identified as standard soil conservation measures which constitute agricultural BACM.

a) Reduced tillage farming practices;
b) tree rows;
c) other physical windbreaks;

[1] A sunflower seed processing plant in Goodland, Kansas, that produces crude vegetable oil and meal from sunflower seeds.

1) grass barriers;
2) annual (e.g., sunflower) barriers;
3) buffer strips; and
4) “snow” fences;

d) cover crops;
e) strip cropping;
f) crop residues; and
g) emergency tillage

Soil erosion specialists at the federal and state levels have been working for approximately seventy five years to develop and evaluate potential mitigating measures. These soil conservation experts continue to implement measures that prove effective for the reduction or prevention of blowing dust. Numerous measures have been applied and are currently in place across Kansas in order to minimize the effects of wind erosion. The United States Department of Agriculture - Agricultural Research Service (USDA-ARS) Wind Erosion Research Unit (WERU) located at Kansas State University (KSU) has achieved the following:

a) Evaluated emergency till practices and demonstrated their effectiveness in halting wind erosion as it started;
b) Evaluated vegetative and non-vegetative mulches and demonstrated that standing vegetation can be five to ten times more effective at reducing wind erosion than material laying flat;
c) Evaluated the relative effectiveness of different plant species in windbreaks;
d) Established the use of feedlot wastes as an effective method for erosion control; and
e) Established the use of permanent grass wind barriers and annual crop control strips, and evaluated the relative effectiveness of their spacing, position, and size in reducing wind erosion.

The areas south and west of Goodland, extending across western Kansas into northwest Oklahoma and Texas, eastern Colorado, and into northeast New Mexico is natural grassland and farmland (Figure 4-1). During 2013, this area was experiencing long-term drought conditions (Figure 2-7). The drought-induced decrease in vegetative cover with dry grassland, poor crop production, and lack of snow cover (Figure 5-2), resulted in increased exposure of topsoil. As a result of the increasingly dry topsoil, bare areas were covered with a layer of fine loose granules (crustal dust).

USDA: Natural Resources Conservation Service (NRCS)

1. *Conservation Reserve Program*

Sherman County is a predominately agricultural area that is made up of 675,698 acres of land area – 657,942 acres (or 97.3%) of which is land in farms. Of the farm land acreage, cropland accounts for almost half of the total (323,248 acres). Water, and often the lack of it, coupled with the frequent high winds experienced during late fall and early spring can destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion. Most of Sherman

County cropland acreage is farmed using dryland practices (versus irrigated) and consists of soils classified as highly-erodible-land (HEL) by the Department of Agriculture.

Recognizing the problems associated with erodible land and other environmental-sensitive cropland, the U.S. Department of Agriculture (USDA) included conservation provisions in the Farm Bill. This legislation created the Conservation Reserve Program (CRP) to address these concerns through conservation practices aimed at reducing soil erosion and improving water quality and wildlife habitat.

The CRP encourages farmers to enter into contracts with USDA to place erodible cropland and other environmentally-sensitive land into long-term conservation practices for 10-15 years. In exchange, landowners receive annual rental payments for the land and cost-share assistance for establishing those practices.

The CRP has been reasonably successful in Sherman County by placing approximately 39,024 acres of Sherman County cropland, or 12% of total cropland, under contract. Most of this land has been planted with a perennial grass cover to protect the soil and retain its moisture.

While the following initiatives are not meant to be enforceable, many efforts are underway that further reduce blowing dust and its impacts. These include:

- The CRP has moved to include all available area lands into area contracts. Success of the CRP initiatives is measured through ongoing monitoring of the contracts to ensure ample grass coverage to minimize blowing dust.
- CRP sends out information several times per year through radio and the area newspaper to further reach farmers interested in topsoil protection.
- In response to the significant Colorado drought the CRP is working with multiple parties in extensive annual planning efforts to limit blowing dust and its impacts. These planning efforts change year to year depending on the severity of the drought.

2. New Initiatives

While the following initiatives are not meant to be enforceable, the Natural Resources Conservation Service has many efforts underway in western Kansas that further reduce blowing dust and its impacts. These include:

- A comprehensive rangeland management program;
- Tree planting program;
- Drip irrigation purchase program, and;

A multi-party drought response planning effort coordinated through the State of Kansas Governor’s office.

KANSAS STATE UNIVERSITY EXTENSION OFFICE

While the following initiatives are not meant to be enforceable, the KSU Extension Office has many efforts underway in western Kansas that further reduce blowing dust and its impacts. These include:

- Crop residue efforts that encourage no- or low-till practices. These have been deemed appropriate and useful in reducing blowing dust.
- Ongoing outreach efforts to educate area agricultural producers on soil management programs. These include one-on-one visitations and annual meetings with various corn and wheat programs to discuss crop management.
- Drought workshops to protect topsoil throughout the county.

The Goodland, Sherman County area was influenced by high winds and blowing dust from the south/southeast and especially the west on the day of the recorded PM_{10} exceedance. Considering the wind speeds and gusts noted during the day that the concentration above the 24-hour NAAQS was recorded (Table 1-1), it is apparent that these conditions were abnormal. The phenomena which gave rise to these blowing dust problems were, therefore, natural events which could not be prevented by application of BACM. With the strength and short duration of this event the farming community was unable to apply emergency tillage or other measures to aid in the reduction of blowing dust. This event also occurred in spite of general area-wide application of accepted good agricultural soil conservation practices.

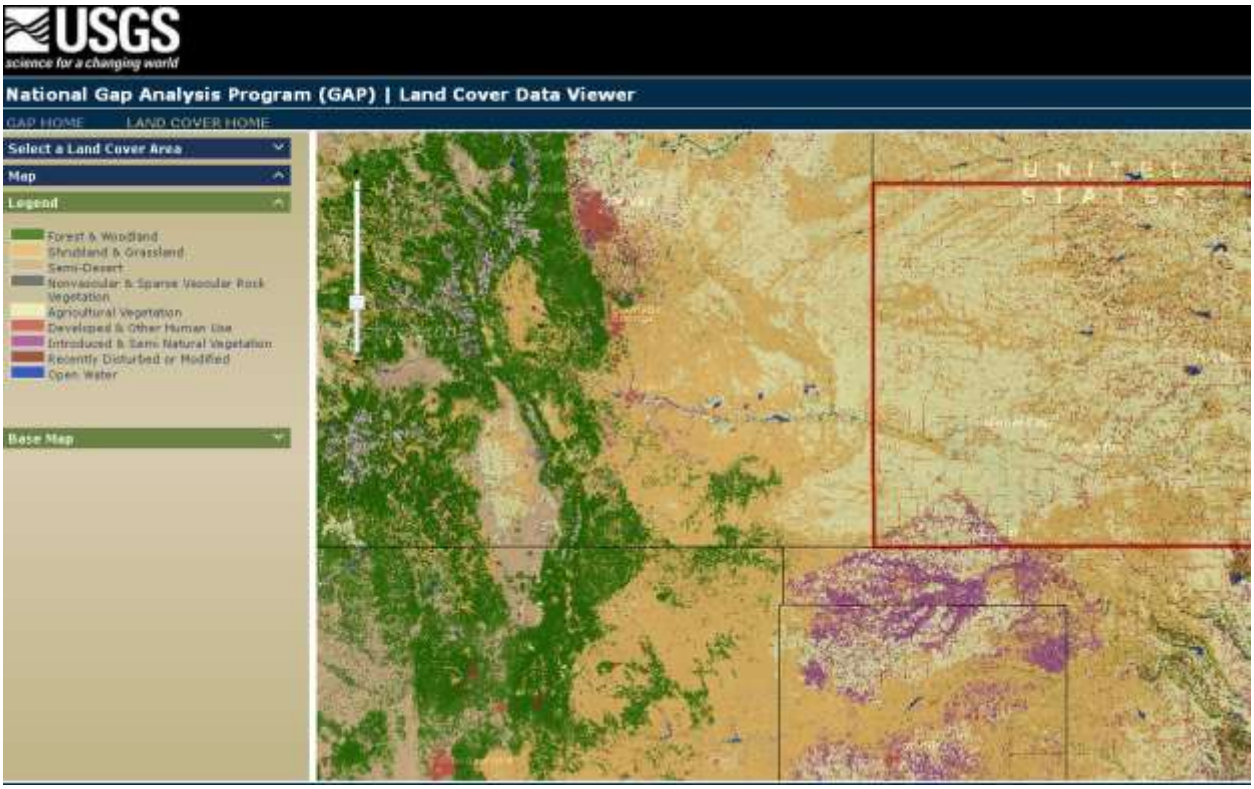


Figure 4-1. Regional (KS, OK, TX, CO, NE, NM) Land Cover Data Map (USGS)

On the basis of these findings, KDHE has concluded that the Goodland area or Sherman County could not have prevented these exceedances at the recorded particulate levels by employing additional localized urban or rural control measures. The increase in PM_{10} concentration on the day of the recorded exceedance was 645% above the normally observed value. The measured value of 162 µg/m^3 at the monitoring site does not related to the annual mean of 25.1 µg/m^3 and especially the monthly mean of 24.2 µg/m^3 (Table 3-1 and Table 3-5). The fact that this was a natural event involving a strengthening low pressure system and associated frontal winds that transported PM_{10} emissions into Sherman County, with a majority of the PM_{10} emissions recorded by the Goodland monitor coming from sources outside of the Goodland area, provides strong evidence that the event and exceedance of February 9, 2013 recorded in the Goodland area was not reasonably controllable or preventable.

5. Clear Causal Relationship

5.1 Summary of Results

This section demonstrates the causal relationship between the strong winds associated with an intense storm system and PM_{10} concentrations above 150 µg/m^3 that occurred in Goodland, Kansas on February 9, 2013. In particular, this section provides evidence that (1) a large area of dust affected the Goodland monitor site; (2) Dust (PM_{10}) from areas outside of the Goodland area was transported to the impacted monitor on the day when the 24-hour PM_{10} concentration was above 150 µg/m^3; and (3) the dust storm led to concentrations above 150 µg/m^3. This evidence includes discussion of source locations, meteorological conditions, dust transport, and air quality data for the exceedance day.

Meteorological and air quality data show that the 24-hour PM_{10} concentration exceeding the NAAQS in Goodland, Kansas was caused by dust that became airborn with intense winds associated with a strengthening storm system moving through the area on February 9, 2013. Support is based on source locations relative to the impacted monitor, wind patterns favorable for transport of dust to the impacted monitors, and reduced visibilities with dust reported in the vicinity of the impacted monitor.

5.2 Analysis Methods

Several analysis methods were used to assess whether the 24-hour PM_{10} concentrations above 150 µg/m^3 were caused by this dust storm. Source locations were analyzed in relation to the impacted monitor, and meteorological data were evaluated to determine whether conditions were favorable for transport of dust (PM_{10}) to the impacted monitor. Air quality data and visibility observations were used to assess whether dust was present at the impacted monitor.

5.2.1 Other Unusual Emissions

In addition, KDHE has reviewed media documents, and contacted local agency and KDHE district staff regarding the exceedance day that is the subject of the exceptional event request and are unable to find any emergency conditions or other anthropogenic events that occurred on the day that would potentially cause the high particulate matter readings on the day in question.

5.2.2 Meteorological Conditions and Dust Transport

Dust transport was analyzed by reviewing surface wind observations and model air parcel trajectories. A majoritiy of PM_{10} impacting the Goodland area during the meteorological event of Feburary 8-9, 2013 originated outside of the Goodland area. The contributing source regions to the dust events were somewhat widespread, but the majority of the PM that was transported into Sherman County likely came from areas within eastern Colorado and southwest Kansas to the south and and west of Sherman County. The exact origin of the PM sources is

often difficult to determine due to the less dense monitoring networks in the general source area.

For surface wind analysis, data from METAR sites nearest the impacted monitors were assessed. Table 5-1 shows the pairings of air quality monitors to METAR sites used throughout this report to examine meteorological conditions near the air quality monitors. METAR sites were selected because of their known high data quality. In some locations, the nearest METAR site was located several miles from the impacted air quality monitor. However, meteorological conditions on the dust storm event day was driven by a large-scale storm (e.g., regionally homogeneous). Thus, meteorological conditions observed at the METAR sites were likely very similar to conditions at the air quality monitors. In addition, no other reliable sources of meteorological data were available. Vector winds averaged over several hours were used in this analysis because they represent pollution transport better than scalar winds. These vector winds, along with other meteorological parameters (e.g., temperature), were evaluated with surface and upper-level observations, radar, and satellite maps to obtain a comprehensive view of the meteorological pattern on the day when the 24-hour PM_{10} concentration was above 150 µg/m^3.

Table 5-1. METAR sites used to represent meteorological conditions near air quality monitors with high particulate matter concentrations.

Air Quality Monitors	METAR Site	METAR Site Location	Approx. Distance Between Air Quality and METAR Stations
Goodland	KGLD	Renner Field/Goodland Municipal Airport, Goodland, KS	1.6 miles
Prowers, Lamar, CO	KLAA	Lamar Municipal Airport, Lamar, CO	4.0 miles
K96 & Hydraulic	KAAO	Colonel James Jabara Airport, Wichita, KS	5.2 miles

Atmospheric soundings from KDDC (Dodge City, Kansas) and KAMA (Amarillo, Texas) were used to identify temperature inversions and mixing layers. These features were assessed to determine whether dust at the surface remained in the lower levels of the atmosphere rather than mixing aloft into layers where it would not impact surface air quality monitors. These soundings were also used to determine if high winds located above the surface but below the inversion were able to mix downward to the surface. Confirming that the dust would likely remain in the lower levels of the atmosphere by reviewing the soundings also provided guidance on which trajectory levels were appropriate to assess dust transport.

The Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) was used to create backward trajectories ending at the impacted monitor. Trajectories ending at 50, 500, and 1500m above the impacted monitor was modeled to show flow patterns throughout the surface-based mixed layer where dust was likely present. Trajectory heights above the surface were also examined over the course of each trajectory path to determine whether dust remained

near the surface (e.g., near the impacted monitor). Trajectory images were created at hourly intervals during the 24-hour window contributing to the 24-hour PM_{10} concentrations above 150 $\mu g/m^3$ at the Goodland monitor; the entire suite of trajectories created can be found in Appendix C.

5.2.3 Air Quality Conditions

Time-series of air quality and meteorological parameters were analyzed to assess the presence of dust at the impacted monitors. Specific meteorological conditions (such as dust or haze) reported at airports by human observers were also included.

5.3 Findings

This subsection contains the results of the causal relationship demonstration for the day when the 24-hour PM_{10} concentrations were elevated or above 150 $\mu g/m^3$. Potential source locations, meteorological conditions and dust transport, and air quality conditions are described for the event day.

February 9, 2013

The results below demonstrate that an area- to region-wide dust event caused the 24-hour PM_{10} concentrations above 150 $\mu g/m^3$ at the Goodland monitor on February 9, 2013. Factors supporting this conclusion include:

- Low-level winds and model trajectories showing transport of dust to the impacted monitors.
- Reductions in visibility, increases in PM concentrations, and visual reports of dust at or near the impacted monitors.
- 24-hour PM_{10} concentrations below 150 $\mu g/m^3$ at monitors that were not impacted by dust.
- No other unusual emission sources that would have caused the high PM_{10} concentrations.

Meteorological Conditions and Dust Transport

The PM_{10} exceedance of the NAAQS at Goodland on February 9, 2013 was the consequence of a strengthening low pressure system and associated frontal boundaries, combined with long-term drought conditions across the region which caused significant blowing dust. Strong south winds occurred at the surface ahead of the occluded and cold fronts which was near the Colorado and Kansas border at 5p.m. as shown in Figure 5-1. As the center of low pressure moved east, a cold front passed through Goodland causing winds to become westerly and increase in speed with a peak gust of 57.5 mph occurring at 5:35p.m. MST (Table 5.1). Despite the event occurring during the winter season, a distict lack of snow cover (Figure 5-2)

was present across the Western Plains which left the ground bare over all potential source regions.

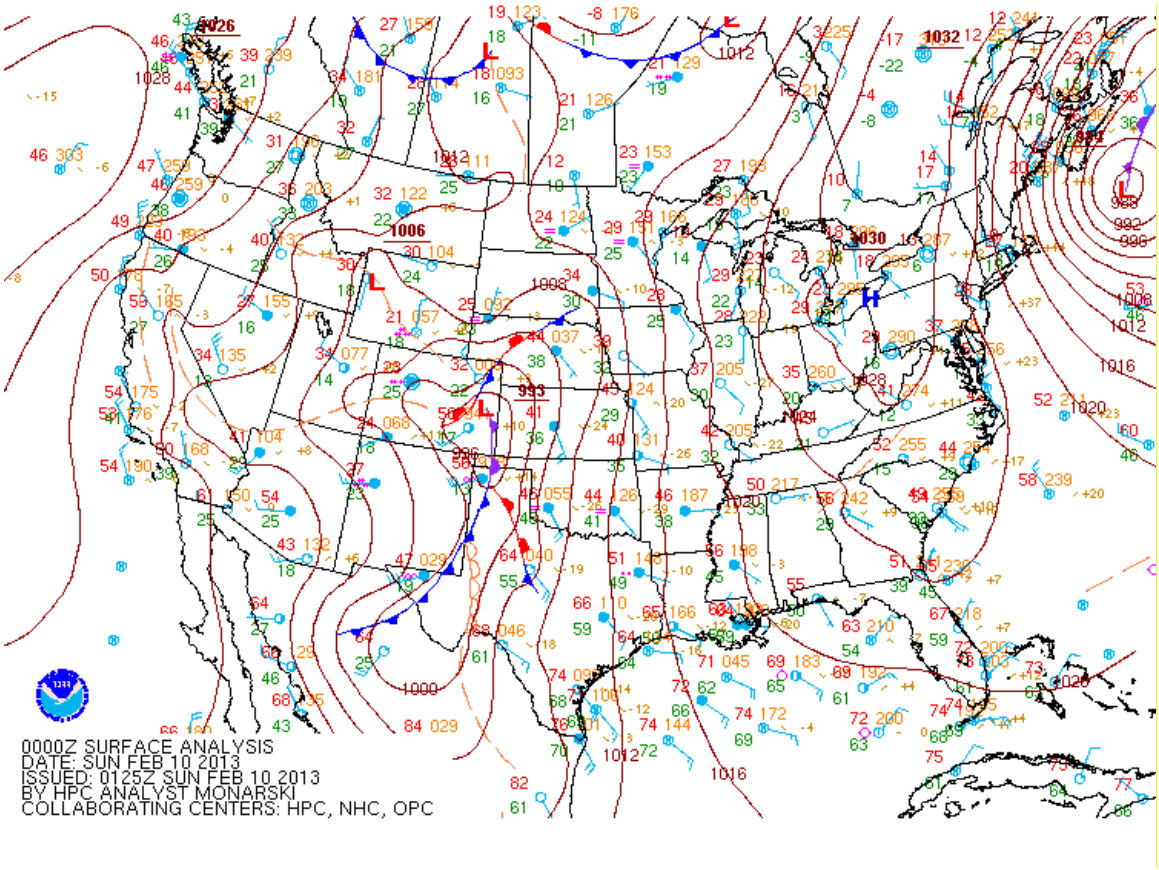


Figure 5-1. Surface Analysis for 00Z February 10, 2013 (5p.m. MST February 9, 2013) (Hydrometeorological Prediction Center)

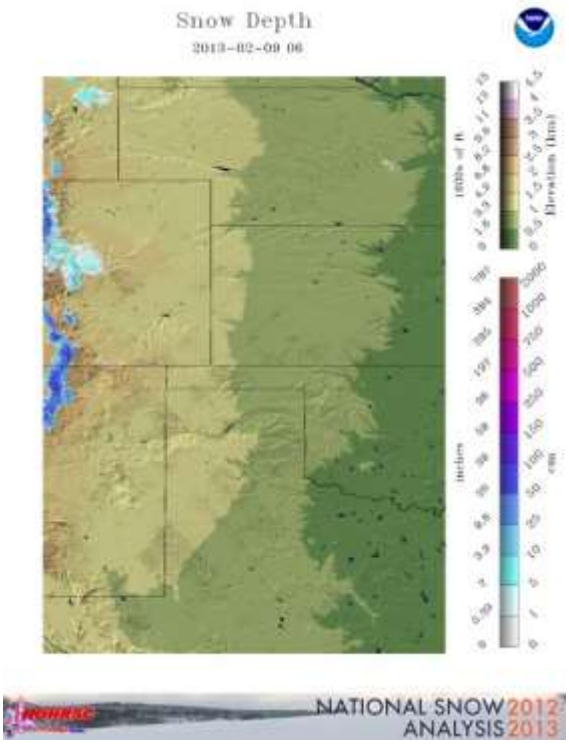


Figure 5-2. Snow Depth Analysis for 06Z February 9, 2013
(11p.m. MST February 8, 2013) (National Operating Hydrologic Remote Sensing Center)

Upper air soundings at Amarillo, Texas (AMA) and Dodge City, KS (DDC) are shown in Figure 5-3 and Figure 5-4 respectively. Each sounding has been annotated to show where a inversion is occurring. An inversion is located where the temperature begins to warm as you rise in height. This produces a cap in the atmosphere where air below mixes together and creates the mixed boundary layer. In both soundings provided this would allow the winds near the top of the mixed boundary layer to mix down and reach the surface. Dodge City shows a 55 knot (64 mph) wind aloft, which indicates the wind gust of 57.5 mph which occurred at Goodland was likely the result of strong mixing. This inversion and mixed layer would have also allowed any dust or particulate matter above the surface to mix down to the surface.

While boundary layer mixing was at its peak and the strongest surface wind gusts were occurring, visibilities at Goodland were limited the greatest with a report of 1 mile at 5:17p.m. MST. This maximum reduction of visibilities was the result of particulate matter above the surface, which was transported from eastern Colorado and eastern New Mexico, being mixed to the surface, and strong surface winds producing more suspended particulate matter from eastern Colorado and adjacent areas of western Kansas. Sustained daily averaged wind speeds of 20 mph or greater, hourly averaged wind speeds greater than 25 mph and gusts of 40 mph or higher have been shown to cause blowing dust in western Kansas (*State of Kansas PM_{10} Natural Events Action Plans (NEAP) for Morton and Sedgwick Counties*- Appendix E).[2]

[2] With the promulgated Exceptional Events Rule (EER) in place, the EER superseded previous natural events guidance including NEAPs (that were not approved as part of a SIP).

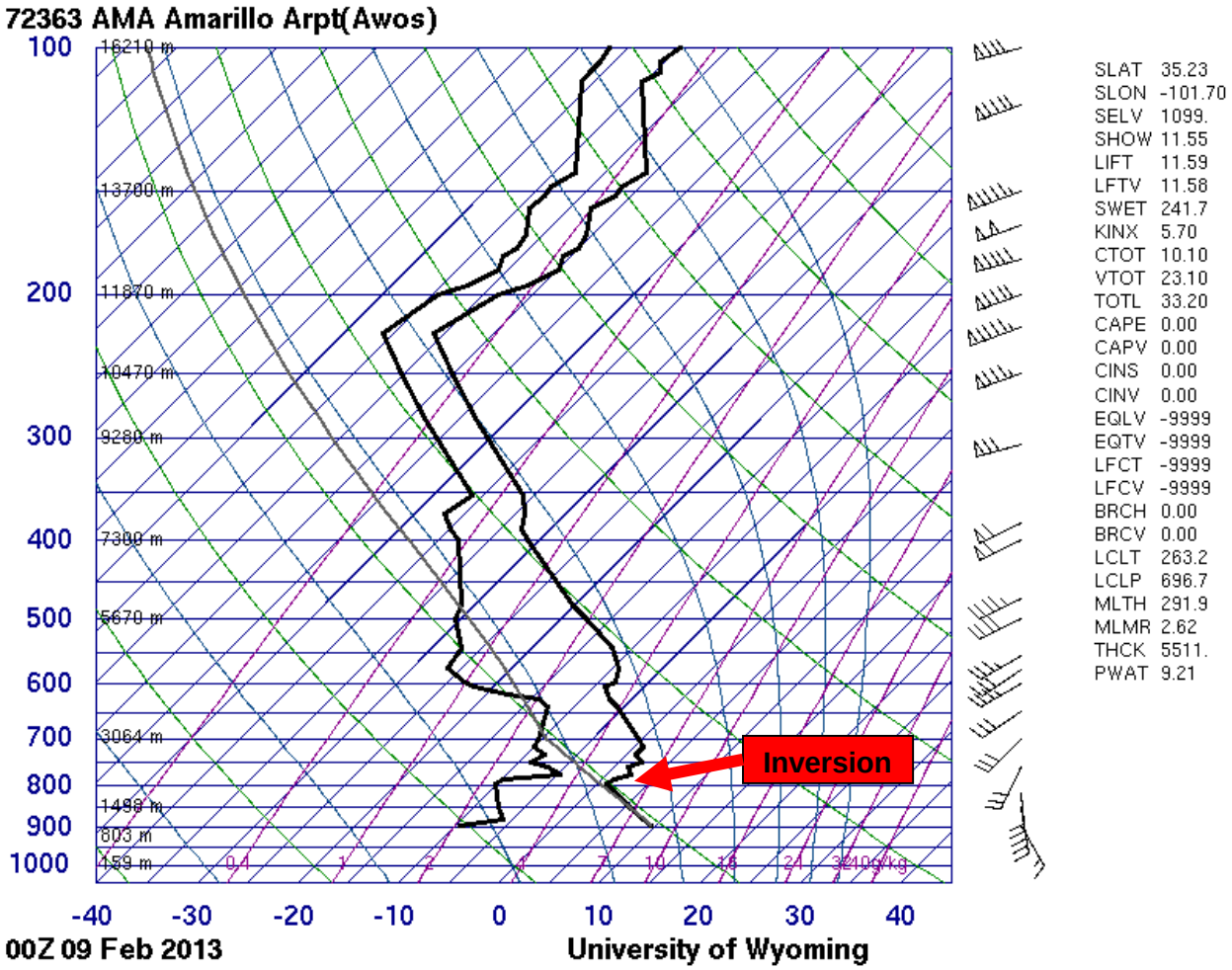


Figure 5-3. Amarillo, TX Upper Air Sounding for 00Z February 9, 2013 (5p.m. MST February 8, 2013) (University of Wyoming's Archive of NWS Upper Air Soundings)

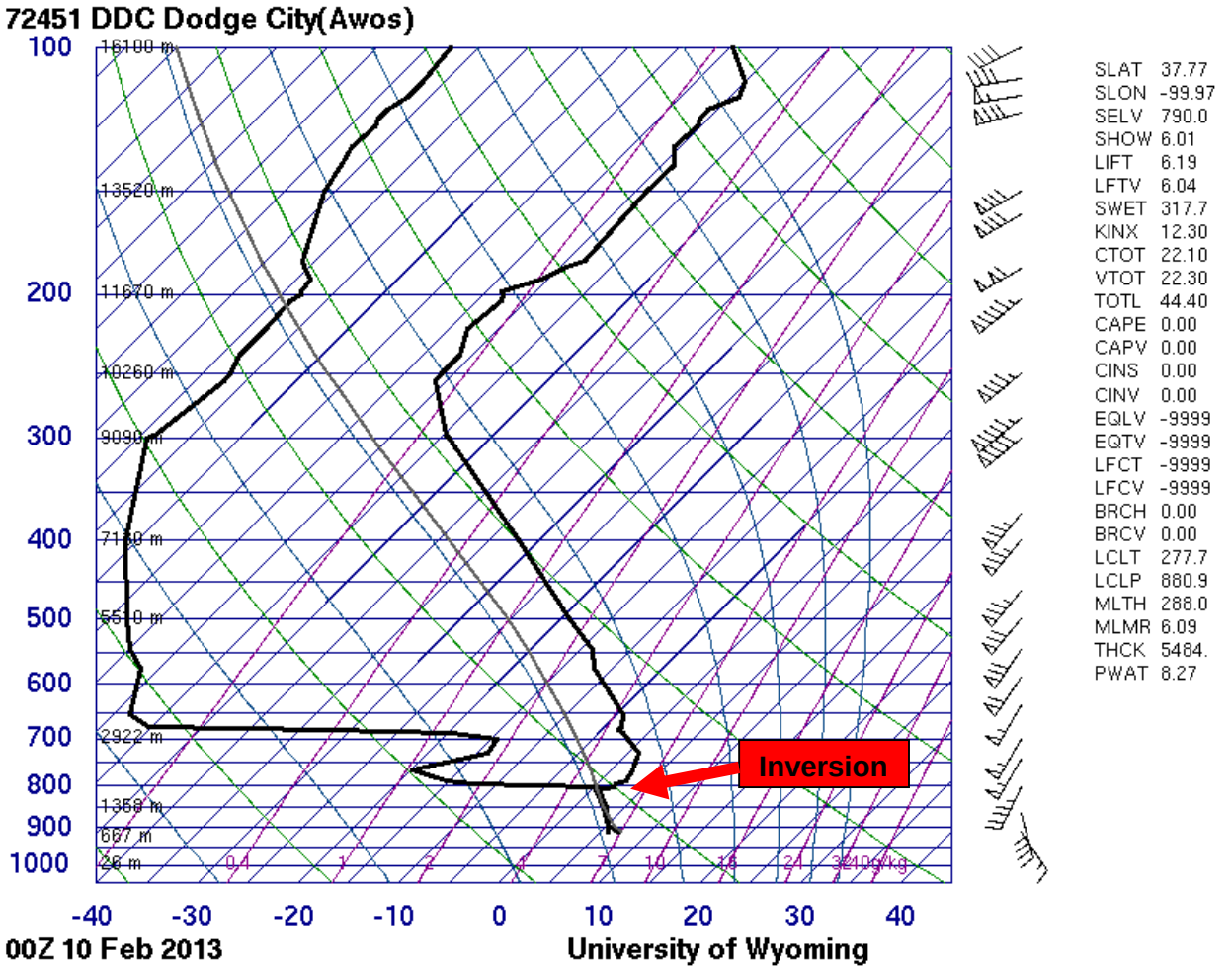


Figure 5-4. Dodge City, KS Upper Air Sounding for 00Z February 10, 2013 (5p.m. MST February 9, 2013) (University of Wyoming's Archive of NWS Upper Air Soundings)

Tables 5-2 through 5-4 show the National Weather Service observations for the three sites of Goodland, Dodge City (about 143 miles southwest of Goodland), and Lamar, CO (about 100 miles south southwest of Goodland). National Weather Service high wind watches, warnings and dust warnings for the area for February 9, 2013 are also shown in Appendix B. The observations show that winds in excess of the thresholds identified for elevated PM_{10} in blowing dust (*State of Kansas PM_{10} Natural Events Action Plans (NEAP) for Morton and Sedgwick Counties*- Appendix E) occurred across the area. Hourly averaged sustained winds of 25 mph or greater, wind gusts of 40 mph or greater, reduced visibility, and the weather type of "haze" are highlighted in yellow.

Table 5-2. Wind and Weather observations for Goodland, KS on February 9, 2013 (NCDC). Speeds at or above the blowing dust thresholds, and haze and reduced visibility (caused by dust) have been highlighted in yellow.

Time (MST) Feb. 9	Temperature (F)	Relative Humidity (%)	Wind Speed (MPH)	Wind Gust (MPH)	Wind Direction (Degrees)	Weather	Visibility (Miles)
12:53 AM	35.1	46	21.9	-	180	Clear	10
1:53 AM	36	43	21.9	-	180	Clear	10
2:53 AM	34	46	19.6	27.6	190	Clear	10
3:53 AM	35.1	46	19.6	-	180	Clear	10
4:53 AM	36	44	18.4	-	190	Clear	10
5:53 AM	34	48	18.4	-	180	Clear	10
6:53 AM	32	52	9.2	-	150	Clear	10
7:53 AM	35.6	44	8.1	-	160	Clear	10
8:53 AM	44.1	32	27.6	34.5	180	Clear	10
9:53 AM	48.9	29	29.9	35.7	180	Clear	10
10:53 AM	52	30	25.3	32.2	190	Clear	10
11:53 AM	54	29	21.9	29.9	180	Clear	10
12:53 PM	55.9	27	28.8	34.5	170	Clear	10
1:53 PM	57	25	27.6	34.5	170	Clear	10
2:53 PM	57	27	32.2	39.1	170	Clear	10
3:53 PM	54	33	29.9	41.4	160	Mostly Cloudy	10
4:53 PM	53.1	37	15	32.2	180	Overcast	10
5:06 PM	51.8	30	27.6	39.1	250	Haze	2.5
5:09 PM	50	32	31.1	40.3	260	Haze	1.5
5:17 PM	46.4	40	36.8	47.2	270	Haze	1
5:35 PM	44.6	46	39.1	57.5	290	Light Rain	2
5:40 PM	44.6	46	34.5	48.3	280	Light Rain	3
5:53 PM	44.1	45	33.4	42.6	300	Overcast	8
6:53 PM	37.9	62	18.4	-	340	Overcast	10
7:53 PM	36	73	13.8	-	10	Overcast	10
8:53 PM	34	82	12.7	-	300	Overcast	10
9:53 PM	30	96	20.7	25.3	330	Light Snow	1.5
10:53 PM	28	92	21.9	-	320	Overcast	5
11:53 PM	28	85	25.3	33.4	310	Overcast	9

Table 5-3. Wind and Weather observations for Lamar, CO on February 8, 2013 (NCDC). Speeds at or above the blowing dust thresholds, and haze and reduced visibility (caused by dust) have been highlighted in yellow.

Time (MST) Feb. 8	Temperature (F)	Relative Humidity (%)	Wind Speed (MPH)	Wind Gust (MPH)	Wind Direction (Degrees)	Weather	Visibility (Miles)
1:53 AM	21.9	60	Calm	-	0	Clear	10
2:53 AM	24.1	62	4.6	-	130	Clear	10
3:53 AM	30.9	57	6.9	-	200	Clear	10
4:53 AM	30.9	57	10.4	-	230	Clear	10
5:53 AM	36	50	15	21.9	210	Clear	10
6:53 AM	34	54	10.4	-	210	Clear	10
7:53 AM	41	43	18.4	26.5	200	Clear	10
8:53 AM	46	35	21.9	31.1	190	Clear	10
9:53 AM	51.1	29	27.6	35.7	190	Clear	10
10:53 AM	52	30	31.1	40.3	190	Clear	10
11:53 AM	55.9	26	29.9	42.6	180	Clear	10
12:53 PM	57.9	24	39.1	46	190	Clear	10
1:53 PM	57	26	39.1	49.5	190	Clear	10
2:51 PM	55.4	26	29.9	47.2	190	Haze	2.5
2:53 PM	55	27	38	50.6	190	Haze	2.5
3:06 PM	53.6	28	42.6	54.1	190	Haze	4
3:41 PM	55.4	26	29.9	43.7	190	Haze	5
3:53 PM	54	29	34.5	49.5	190	Haze	6
4:00 PM	53.6	28	32.2	46	180	Haze	2.5
4:12 PM	53.6	28	29.9	36.8	180	Haze	1.8
4:16 PM	53.6	28	27.6	36.8	180	Haze	2
4:24 PM	53.6	28	26.5	35.7	180	Haze	1.8
4:48 PM	51.8	30	31.1	44.9	180	Haze	3
4:53 PM	52	31	31.1	44.9	180	Haze	4
5:05 PM	51.8	30	27.6	36.8	180	Haze	2.5
5:14 PM	51.8	30	28.8	42.6	180	Haze	3
5:38 PM	50	32	31.1	39.1	180	Sctd Clouds	9
5:53 PM	50	33	26.5	36.8	180	Clear	10
6:53 PM	48	36	24.2	35.7	180	Clear	9
7:53 PM	46.9	37	26.5	34.5	190	Clear	10
8:53 PM	46	40	25.3	29.9	200	Clear	10
9:53 PM	46	37	24.2	33.4	200	Clear	10
10:53 PM	46	34	28.8	41.4	190	Clear	10
11:53 PM	44.1	35	29.9	40.3	180	Clear	10

Table 5-4. Wind and Weather observations for Wichita, KS on February 10, 2013 (NCDC). Speeds at or above the blowing dust thresholds, and haze and reduced visibility (caused by dust) have been highlighted in yellow.

Time (CST) Feb. 10	Temperature (F)	Relative Humidity (%)	Wind Speed (MPH)	Wind Gust (MPH)	Wind Direction (Degrees)	Weather	Visibility (Miles)
12:28 AM	42.8	100	20.7	29.9	160	Overcast	2.5
12:47 AM	42.8	100	19.6	29.9	170	Light Rain	3
12:54 AM	43	97	15	29.9	160	Light Rain	5
1:08 AM	44.6	93	16.1	24.2	170	Overcast	9
1:42 AM	44.6	100	20.7	28.8	180	Overcast	4
1:54 AM	45	100	16.1	24.2	210	Overcast	7
2:54 AM	46	100	21.9	28.8	180	Overcast	10
3:54 AM	46.9	N/A	20.7	27.6	190	Overcast	10
4:54 AM	46	N/A	17.3	26.5	190	Mstly Cldy	10
5:32 AM	46.4	N/A	17.3	24.2	190	Sctd Clouds	10
5:54 AM	45	N/A	17.3	-	190	Clear	10
7:54 AM	39	67	13.8	24.2	240	Clear	10
8:54 AM	39.9	63	21.9	33.4	260	Clear	10
9:54 AM	43	53	27.6	42.6	260	Clear	10
10:54 AM	44.1	51	23	34.5	260	Clear	10
11:54 AM	48	44	27.6	35.7	260	Clear	10
12:54 PM	48.9	43	26.5	40.3	260	Clear	10
1:54 PM	51.1	39	20.7	35.7	270	Ptly Cloudy	10
2:54 PM	50	39	24.2	38	290	Sctd Clouds	10
3:54 PM	45	46	32.2	42.6	270	Overcast	10
4:54 PM	45	44	28.8	39.1	290	Mstly Cldy	10
5:54 PM	42.1	49	15	-	300	Clear	10
6:54 PM	41	53	18.4	23	310	Ptly Cloudy	10
7:54 PM	37	62	5.8	-	280	Clear	10
8:54 PM	37.9	60	9.2	-	270	Clear	10
9:54 PM	37.9	57	12.7	-	290	Clear	10
10:54 PM	36	59	9.2	-	290	Clear	10
11:54 PM	35.1	61	13.8	20.7	300	Clear	10

Figures 5-5 and 5-6 show the output for blowing dust from the NAAPS (Navy Aerosol Analysis and Prediction System) Global Aerosol Model for February 9, 2013. The bottom panels in Figures 5-5 and 5-6 show where dust is blowing. They show a large area of blowing dust extending from west Texas through eastern Colorado and western Kansas and continuing northward into Canada. As the day progressed and wind speeds increased from the strong storm system approaching from the west, the concentration of dust increased dramatically across southeast Colorado and into southwest Kansas. The NAAPS model output is based on soil moisture content, soil erodibility factors, and modeled meteorological factors conducive to blowing dust. For a description of NAAPS see: http://www.nrlmry.navy.mil/aerosol_web/Docs/globaer_model.html

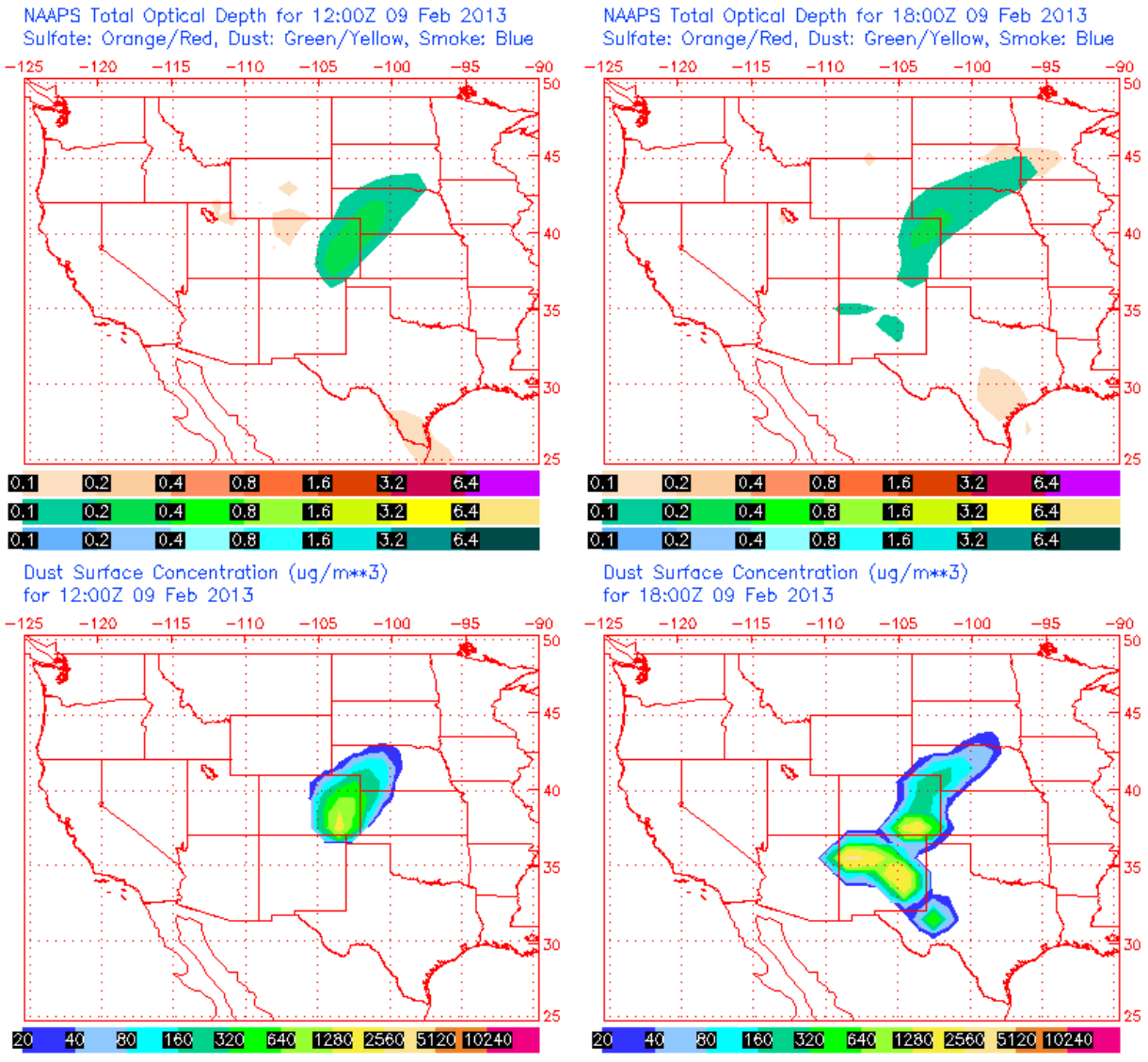


Figure 5-5. NAAPS forecast optical depth and surface dust for 5a.m. (left) and 11a.m. (right) MST February 9, 2013 (NRL/Monterey Aerosol Modeling)

Although NAAPS forecast products can over predict dust PM_{10}, they do provide an independent calculation of the potential for blowing dust and the spatial extent of blowing dust for this event. The highest NAAPS concentrations of dust PM_{10} are in southeast Colorado and eastern New Mexico. Forecast products for February 9, 2013 indicate significant dust concentrations originating over eastern New Mexico and southeast Colorado, spreading northeast-east with time.

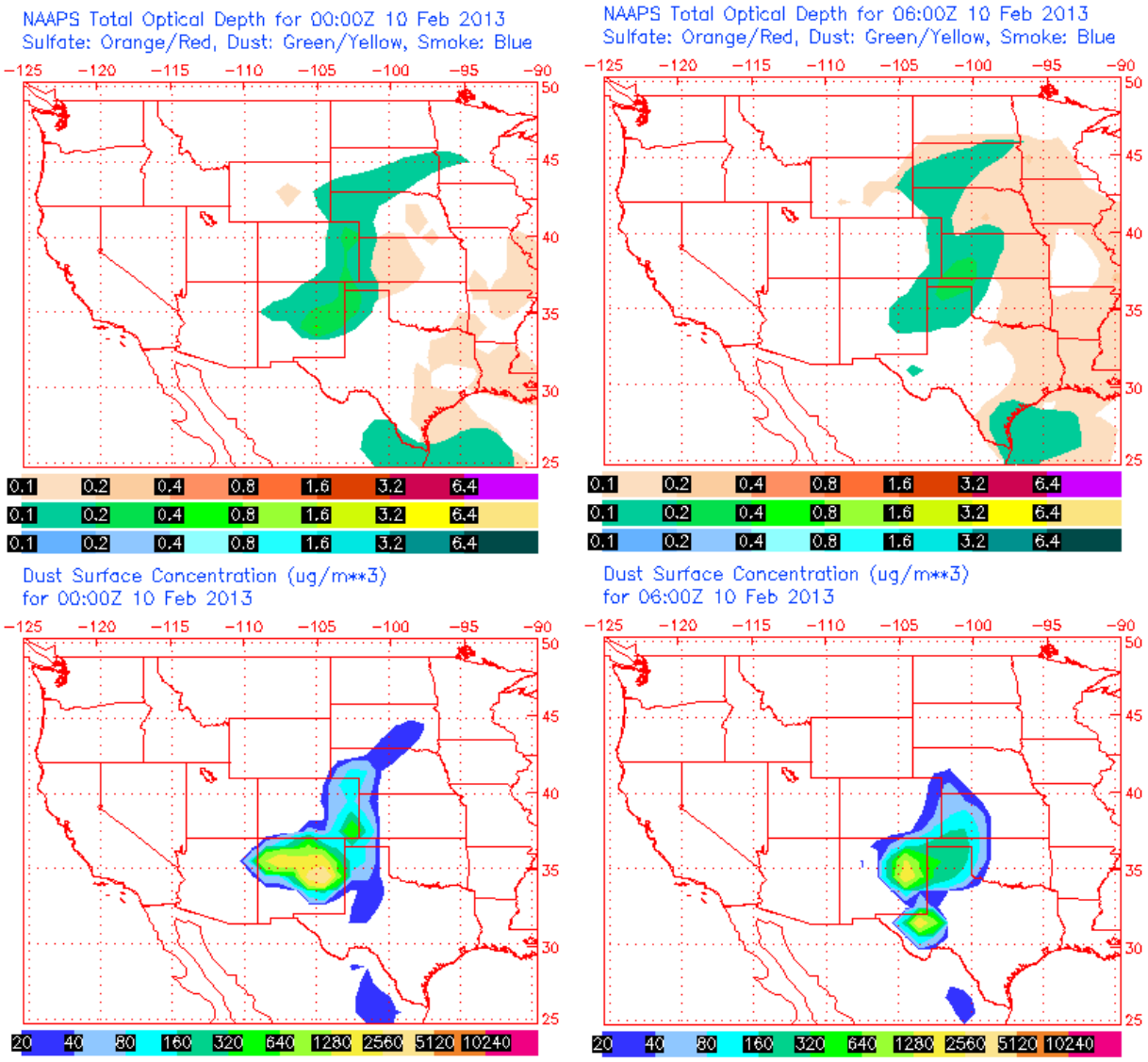


Figure 5-6. NAAPS forecast optical depth and surface dust for 5p.m. (left) and 11p.m. (right) MST February 9, 2013 (NRL/Monterey Aerosol Modeling)

Figures 5-7 through 5-9 contain back trajectory plots for Goodland during the peak period of winds and reduced visibilities. The back trajectories are from the NOAA HYSPLIT model using NAM12 meteorological input data (http://ready.arl.noaa.gov/HYSPLIT.php). The back trajectory paths are originated at varying heights within the mixed boundary layer as determined by the Dodge City upper air sounding (Figure 5-4). Back trajectory plots show that air parcels within the mixed boundary layer originate from western Kansas, eastern Colorado, eastern New Mexico and the panhandle of Oklahoma and Texas. These back trajectories indicate source regions for the Goodland Exceptional Event included areas highlighted by NAAPS forecast with high surface dust concentrations, and monitored locations such as Lamar, CO (Table 3-2) which also exceeded NAAQS for PM_{10} concentrations.

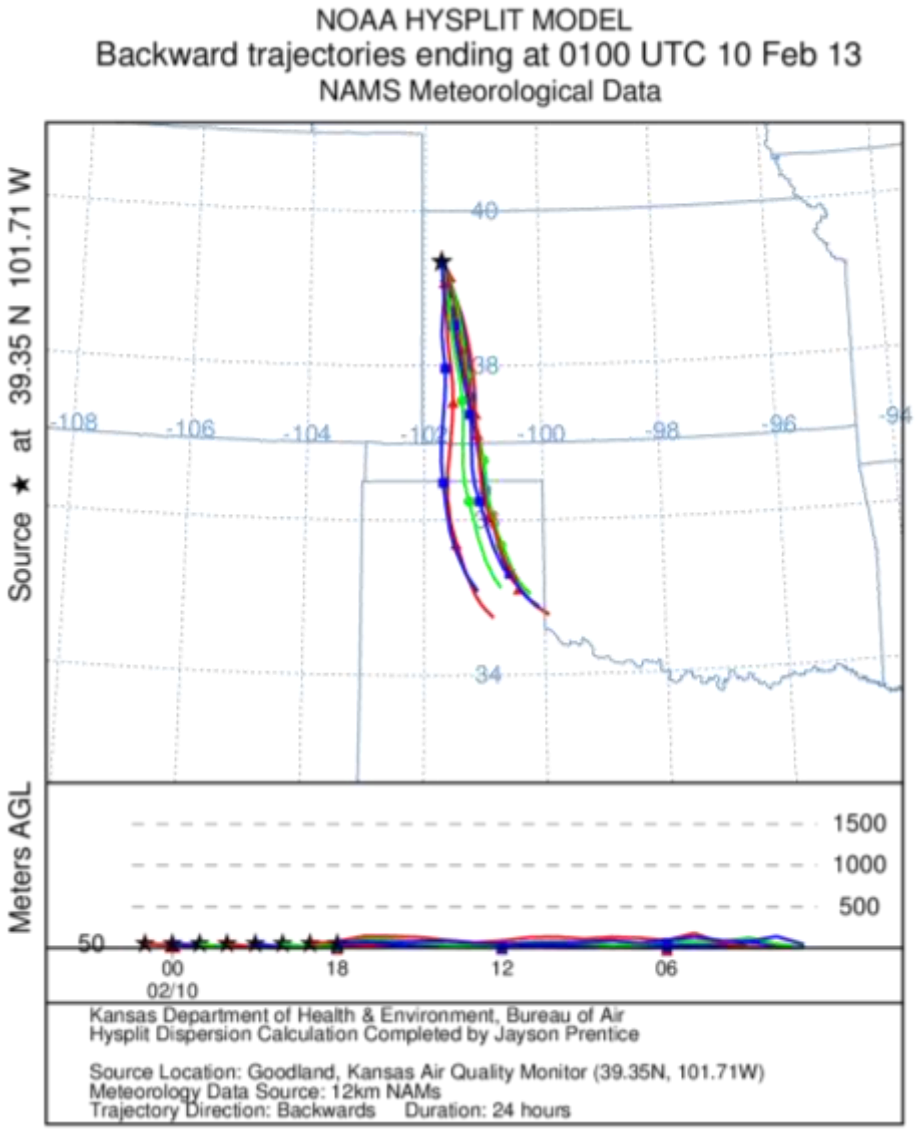


Figure 5-7. NOAA HYSPLIT 24-hour back trajectory plots from 50 meters for each hour during the windiest period on February 9, 2013.

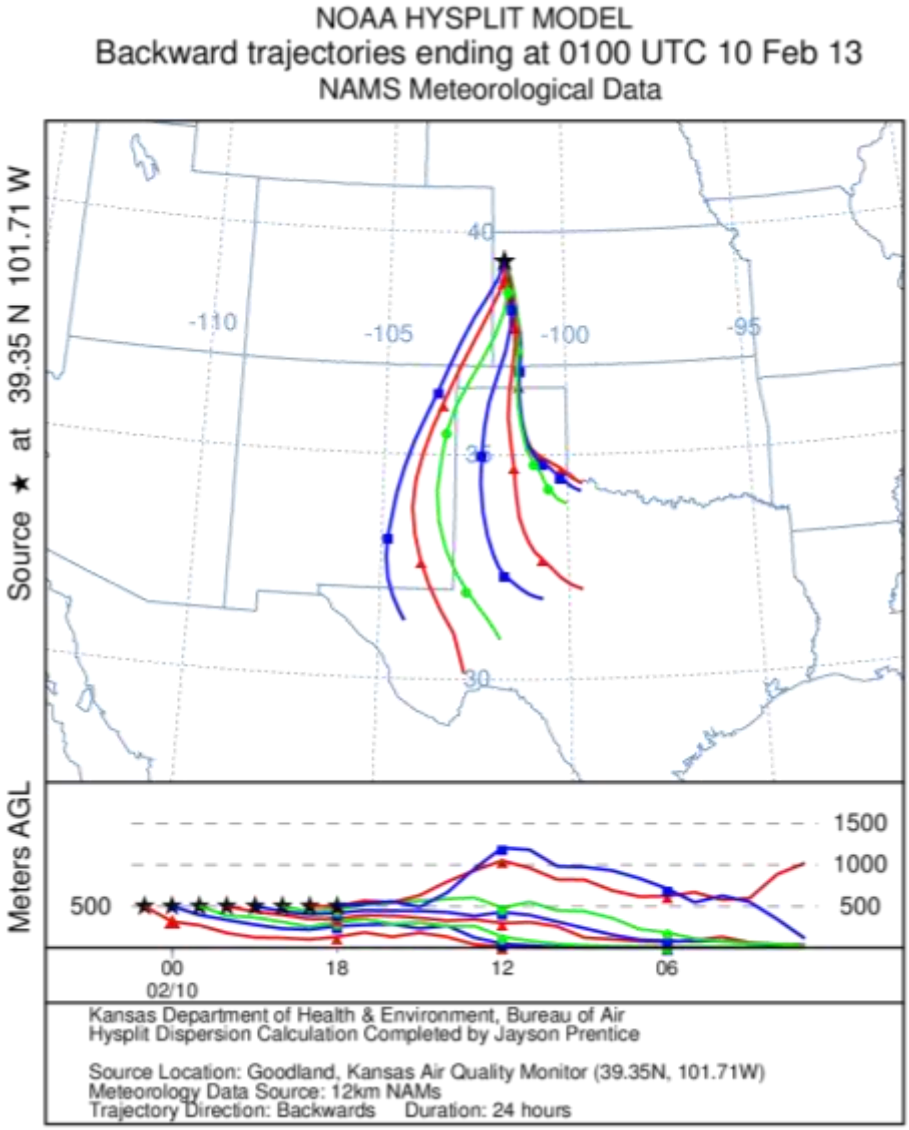


Figure 5-8. NOAA HYSPLIT 24-hour back trajectory plots from 500 meters for each hour during the windiest period on February 9, 2013.

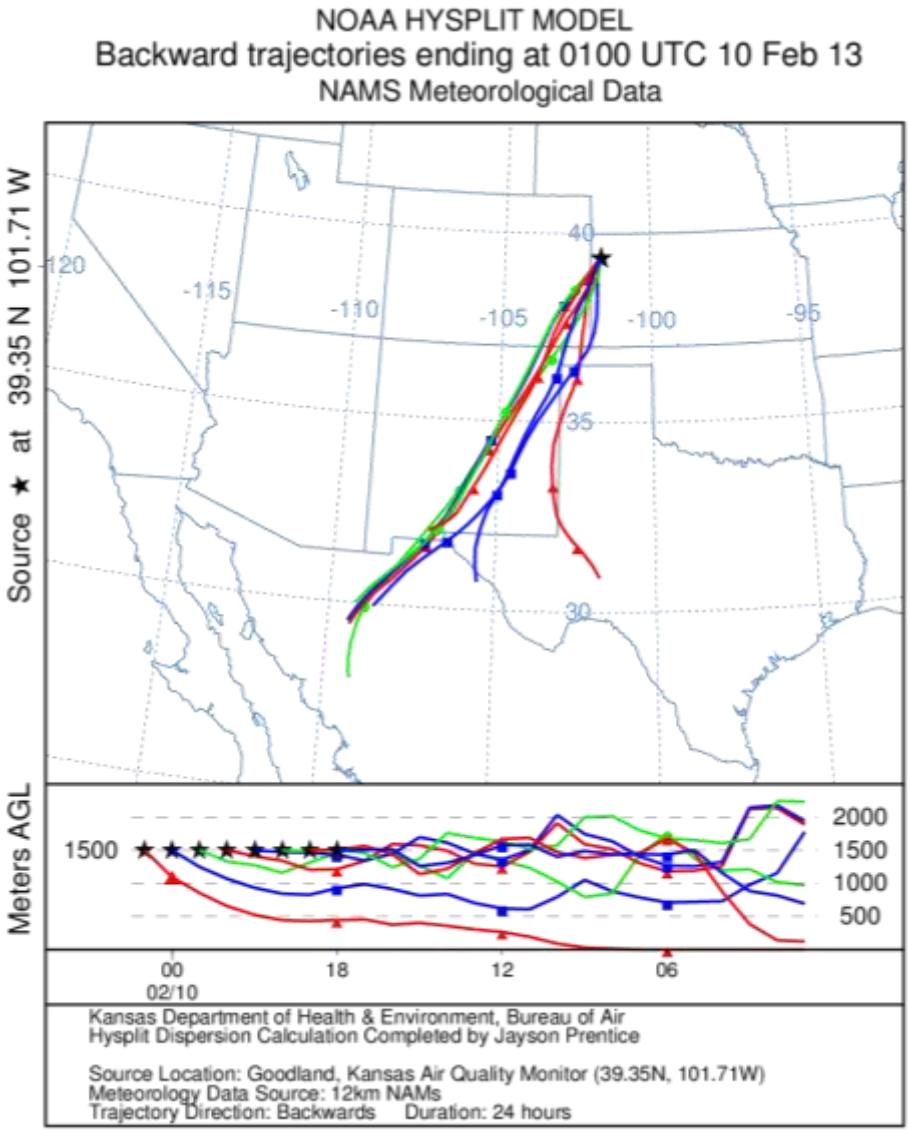


Figure 5-9. NOAA HYSPLIT 24-hour back trajectory plots from 1500 meters for each hour during the windiest period on February 9, 2013.

An analysis of the annual frequency of dust storms (Orgill and Sehmel, 1976) in the western half of the U.S. suggests that large areas of eastern Colorado, western Kansas, Texas, New Mexico and Arizona are source regions for blowing dust (see Figure 5-12). The back trajectories in Figure 5-11 cross these source areas and suggest that dust from upwind states can contribute to PM_{10} concentrations at Goodland during regional high-wind events.

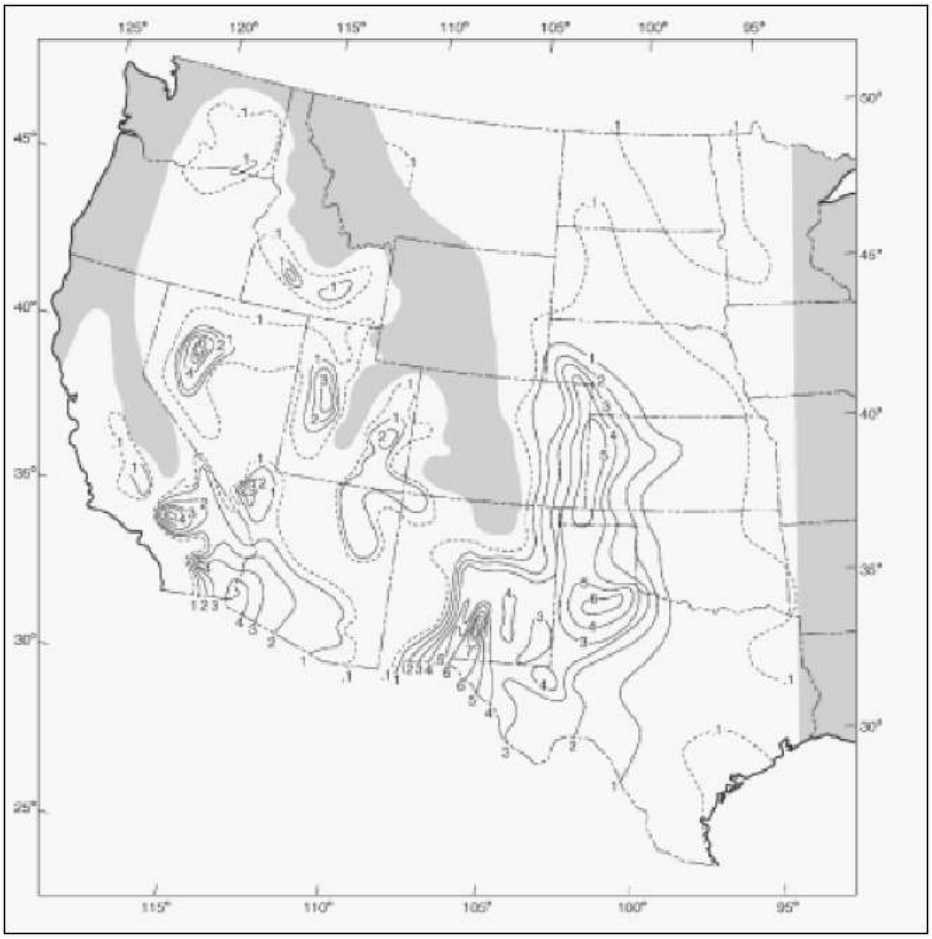


Figure 5-10. Number of dust storms per year from: Orgill, M.M., Sehmel, G.A., 1976. Frequency and diurnal variation of dust storms in the contiguous USA. **Atmospheric Environment 10**, 813–825.

The PM_{10} exceedance at Goodland on February 9, 2013, would not have occurred if not for the following: (a) dry soil conditions over eastern Colorado, western Kansas, western Oklahona and Texas, and northeast New Mexico; and (b) the tight surface pressure gradient and strong upper level winds mixing to the surface that led to strong gusty surface winds over the aforementioned region. Clearly the PM_{10} exceedance at Goodland is due to an exceptional event associated with regional windstorm and caused emissions from erodible soil surfaces over a large area. These sources are not reasonably controllable during a significant regional windstorm under abnormally dry or moderate to severe drought conditions.

6. "But For" Analysis

Section 50.14(c)(3)(iv)(D) in 40 CFR part 50 requires that an exceptional event demonstration must satisfy that "[t]here would have been no exceedance or violation but for the event." The prior sections of this submittal have provided detailed information that the exceedance at the Goodland monitor on February 9, 2013 was not reasonably controllable or preventable and there is a clear causal relationship between transported PM_{10} from very strong winds associated with an intensifying storm system originating in areas outside of the Goodland area and the measured exceedance at the Goodland monitor. The weight of evidence in these sections demonstrates that but for the existence of emissions generated by these very strong winds and associated transported PM_{10}, there would have been no exceedances of the 24-Hour PM_{10} standard.

As detailed in Section 4, all reasonable agricultural control measures were in place and actively employed before, during, and after the exceedance of February 9, 2013. Local regulatory agencies, industry and the general public were alerted to the possibility of dust storms due to very strong winds through daily forecasts and media reports. On the ground observations recorded during the events consistently identify transported or re-entrained PM_{10} (dust) as the cause of the elevated concentrations near the exceeding monitor.

As shown in Section 5, detailed maps establish a clear causal relationship between the arrival of emissions generated by very strong winds associated with a intense storm system and elevated PM_{10} concentrations at the monitor. Multiple, independent measurements of wind speed, wind direction, and visibility all point to the presence of very strong winds as the delivery vehicle for transported PM_{10} into the Goodland area. The source regions for the transported PM_{10} are clearly identified as areas to the west and south of the Goodland area, especially in southeast Colorado.

Figure 6-1 shows the monitored values recorded at the Goodland monitor before and after the event of February 9, 2013. As you can see from the graph, PM_{10} readings were significantly below the reading of February 9 and are more in line with expected average PM_{10} readings from this monitor. This is yet another piece of evidence that this event or exceedance would not have occurred but for the very strong winds associated with the storm system that moved through the area on February 9, 2013.

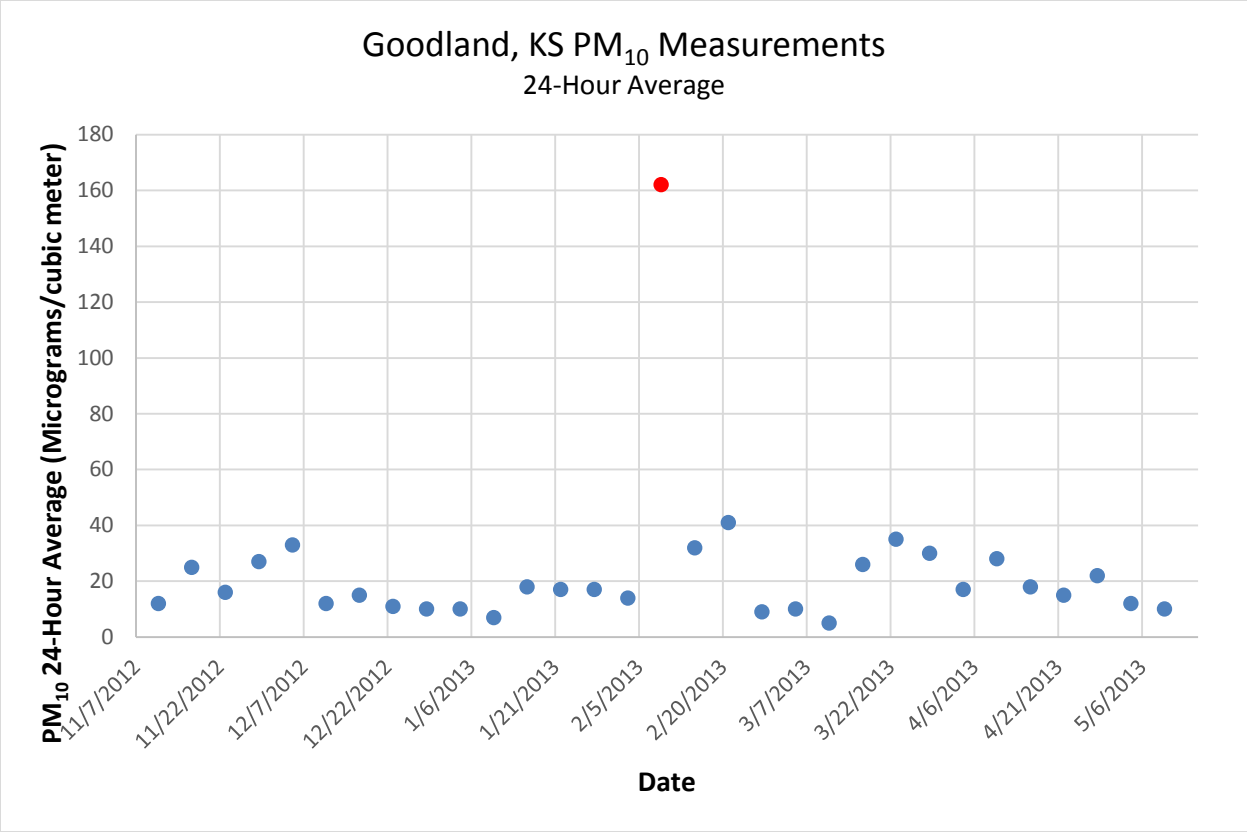


Figure 6-1. Goodland PM_{10} measurements from November 7, 2012 to May 9, 2013

An estimation of PM_{10} due to the event is presented here and in Table 6-1. Based on the entirety of data in the Historical Fluctuations section, a conservative estimate of the "typical" values in February would have been between 47.7 and 60.4 µg/m^3 (corresponding to the 75th and 85th Percentile values) for the Goodland monitor. Using these conservative values as "typical" would indicate that the event provided an additional 102 – 114 µg/m^3 for the Goodland monitor.

Table 6-1. Typical February PM_{10} Values for Goodland

Site	Event Day Concentration (µg/m^3)	February Median (µg/m^3)	February Mean (µg/m^3)	Feb. 75th Perc. (µg/m^3)	Oct. 85th Perc. (µg/m^3)	Est. Concentration Above Typical (µg/m^3)
Goodland	162	12	24.2	47.7	60.4	

The body of evidence presented in this submittal provides no alternative that could tie the exceedance of February 9, 2013 to any other causal source but transported and re-entrained PM_{10} generated from very strong winds associated with an intense storm system, confirming that there would have been no exceedance but for the presence of these uncontrollable natural events.

7. Conclusions

The exceedance that occurred on February 9, 2013 satisfies the criteria of 40 CFR 50.1(j) and meets the definition of an exceptional event. These criteria are:

- The event affects air quality.
- The event is not reasonably controllable or preventable.
- The event is unlikely to reoccur at a particular location or [is] a natural event.

A. Affects Air Quality

As stated in the preamble to the Exceptional Events Rule, the event in question is considered to have affected air quality if it can be shown that there is a clear causal relationship between the monitored exceedance and the event, and that the event is associated with a measured concentration in excess of normal historical fluctuations. Given the information presented in Sections 2, 3, 4 and 5, we can reasonably conclude that the event in question affected air quality.

B. Not Reasonably Controllable or Preventable

Section 50.1(j) of Title 40 CFR Part 50 requires that an event must be "not reasonably controllable or preventable" in order to be defined as an exceptional event. This requirement is met by demonstrating that despite reasonable agricultural control measures in place within Sherman County and the Goodland area, high wind conditions overwhelmed all reasonably available controls. Despite best available agricultural control measures, high wind conditions associated with a strengthening storm system brought high concentrations of PM_{10} emissions into, and overwhelmed controls within, the Goodland area. The event discussed in this document that caused the exceedance in this request (see Sections 2 and 5) was caused by very high winds that transported dust into Sherman County from areas largely outside of the Goodland area. The fact that this was a natural event involving strong winds that transported PM_{10} emissions into Sherman County, with a majority of the PM_{10} emissions recorded by the Goodland monitor coming from sources outside of the Goodland area, provides strong evidence that the event and exceedance of February 9, 2013 were not reasonably controllable or preventable.

C. Natural Event

As discussed above, the event shown to cause this exceedance was emissions of PM_{10} driven by high winds caused by an intensifying storm system moving through the area on February 9, 2013. This event therefore qualifies as a predominantly natural event with only a very small anthropogenic contribution.

In summary, the exceedance of the federal 24-hour PM_{10} standard on February 9, 2013, would not have occurred but for the extreme high winds and windblown dust transport from areas largely outside the Goodland area, based on the following weight of evidence:

- The conceptual model created in Section 2 shows the meteorological and climatic conditions that were present to create such a natural event containing high PM_{10} value at the Goodland monitor.

- Historical Fluctuation analyses and graphs in Section 3 showing five years of 24-hour average data for the Goodland monitor depict the atypically high PM_{10} concentration during the February 9, 2013 event. The elevated PM_{10} concentration during this day was exceptional from a historical perspective.

- Section 4 discusses the best available control technologies that are in place in the Goodland area in order to show that the event was not reasonably controllable or preventable. Additionally, newspaper accounts provided in Appendix D helps illustrate the magnitude and scale of this events which supports the claim that the exceedance recorded during this day was not reasonably controllable or preventable.

- The exceedance of the PM_{10} standard recorded on February 9 was tied to very strong winds, as can be seen National Weather Service warnings and meterological summaries of wind speeds from multiple cities in the region in Section 5 and Appendix B.

- Figures in Section 5 show that the timing of the increases in wind speeds at monitoring locations and National Weather Service stations during the event is consistent with the timing of elevated PM_{10} concentrations recorded at the monitoring locations in the area.

- Wind directions, NAAPS dust modeling output, and back trajectories, all depicted in Section 5, help show that a significant portion of the dust that impacted Goodland area monitor originated in areas located generally west and south of the Goodland area.

- Approximate increased PM_{10} emissions for this event was provided in Section 6 to give an idea of the magnitude of the dust storm that affected the Goodland area and the amount of PM_{10} that can be transported in during these types of events.

8. References

Draxler, R.R. and Rolph, G.D., 2013. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/HYSPLIT.php). NOAA Air Resources Laboratory, College Park, MD.

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9. APPENDIX A – Additional Language for National Weather Service Products

As a part of a prior exceptional event that occurred, KDHE and the NWS offices that cover the state of Kansas worked together to develop additional language to be added to products pertaining to blowing dust. Such products included are Wind Advisory, High Wind Warning, and Dust Storm Warning. This language will advise the public of potential health effects associated with such dust events and provide proactive steps that they may perform to protect themselves during these events. This language has been implemented as of January 2014.

"*The Kansas Department of Health and Environment recommends that you take preventative measures during this dust (or wind) event, such as staying indoors or wearing protective breathing masks if outside. High dust concentrations can cause respiratory problems, decrease lung activity, aggravate asthma, and lead to potential heart-related problems, especially with children, elderly, or those with pre-existing respiratory conditions.*"

10. APPENDIX B – Goodland and Surrounding NWS offices Advisory and Warning Products for February 9, 2013

GOODLAND NWS

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GOODLAND KS
332 AM MST SAT FEB 9 2013

...WINDY CONDITIONS TODAY AND INTO THIS EVENING...

.SOUTH WINDS WILL INCREASE ACROSS THE CENTRAL HIGH PLAINS REGION
TODAY AHEAD OF A DEEPENING LOW PRESSURE SYSTEM EXPECTED TO MOVE
ACROSS THE AREA TONIGHT.

COZ090>092-KSZ001>004-013>016-027>029-041-042-NEZ079>081-092100-
/O.NEW.KGLD.WI.Y.0003.130209T1700Z-130210T0200Z/
YUMA-KIT CARSON-CHEYENNE CO-CHEYENNE KS-RAWLINS-DECATUR-NORTON-
SHERMAN-THOMAS-SHERIDAN-GRAHAM-WALLACE-LOGAN-GOVE-GREELEY-WICHITA-
DUNDY-HITCHCOCK-RED WILLOW-
INCLUDING THE CITIES OF...YUMA...WRAY...BURLINGTON...
CHEYENNE WELLS...ST. FRANCIS...ATWOOD...OBERLIN...NORTON...
GOODLAND...COLBY...HOXIE...HILL CITY...SHARON SPRINGS...OAKLEY...
QUINTER...TRIBUNE...LEOTI...BENKELMAN...TRENTON...MCCOOK
332 AM MST SAT FEB 9 2013 /432 AM CST SAT FEB 9 2013/

...WIND ADVISORY IN EFFECT FROM 10 AM MST /11 AM CST/ THIS
MORNING TO 7 PM MST /8 PM CST/ THIS EVENING...

THE NATIONAL WEATHER SERVICE IN GOODLAND HAS ISSUED A WIND
ADVISORY...WHICH IS IN EFFECT FROM 10 AM MST /11 AM CST/ THIS
MORNING TO 7 PM MST /8 PM CST/ THIS EVENING.

* TIMING/DURATION...SOUTH WINDS WILL INCREASE THROUGH THE MORNING
  WITH THE STRONGEST WINDS EXPECTED THROUGH MID AFTERNOON. WINDS
  WILL SUBSIDE FOR A BRIEF TIME AGAIN AFTER SUNSET.

* PEAK WINDS...PEAK SUSTAINED WIND SPEEDS DURING THE AFTERNOON
  BETWEEN 30 AND 35 MPH ARE EXPECTED WITH GUSTS AROUND 35 MPH.

* OTHER IMPACTS...AREAS OF BLOWING DUST MAY RESTRICT VISIBILITIES
  AT TIMES.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WIND ADVISORY MEANS THAT STRONG AND GUSTY WINDS MAY AFFECT
TRAVEL...ESPECIALLY LIGHT WEIGHT OR HIGH PROFILE VEHICLES. BE
PREPARED FOR SUDDEN WIND GUSTS WHICH MAY RESULT IN LOSS OF
VEHICLE CONTROL.

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GOODLAND KS
433 PM MST SAT FEB 9 2013

...WINDY CONDITIONS TODAY AND INTO THIS EVENING...

.SOUTH WINDS WILL INCREASE ACROSS THE CENTRAL HIGH PLAINS REGION TODAY AHEAD OF A DEEPENING LOW PRESSURE SYSTEM EXPECTED TO MOVE ACROSS THE AREA TONIGHT.

COZ091-092-KSZ013-027-100745-
/O.UPG.KGLD.WI.Y.0003.000000T0000Z-130210T0200Z/
/O.NEW.KGLD.HW.W.0002.130209T2333Z-130210T0200Z/
/O.CON.KGLD.HW.A.0002.130210T1200Z-130211T0000Z/
KIT CARSON-CHEYENNE CO-SHERMAN-WALLACE-
INCLUDING THE CITIES OF...BURLINGTON...CHEYENNE WELLS...
GOODLAND...SHARON SPRINGS
433 PM MST SAT FEB 9 2013

...HIGH WIND WARNING IN EFFECT UNTIL 7 PM MST THIS EVENING...
...HIGH WIND WATCH REMAINS IN EFFECT FROM LATE TONIGHT THROUGH SUNDAY AFTERNOON...

THE NATIONAL WEATHER SERVICE IN GOODLAND HAS ISSUED A HIGH WIND WARNING...WHICH IS IN EFFECT UNTIL 7 PM MST THIS EVENING. THE WIND ADVISORY IS NO LONGER IN EFFECT.

* TIMING/DURATION...STRONG WINDS WILL OVERSPREAD THE AREA OVER THE NEXT HOUR.

* PEAK WINDS...SUDDEN WIND GUSTS TO 65 MPH ARE EXPECTED.

* OTHER IMPACTS...BLOWING DUST WILL SEVERELY RESTRICT VISIBILITY IN SOME AREAS AS THE WINDS MOVE INTO THE AREA. THIS AREA OF DUST AND WINDS WILL IMPACT INTERSTATE 70.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A HIGH WIND WARNING MEANS STRONG WINDS ARE EITHER OCCURRING OR IMMINENT WHICH COULD LEAD TO PROPERTY DAMAGE...REDUCED VISIBILITY IN BLOWING DUST...AND LOSS OF VEHICLE CONTROL. A HIGH WIND WARNING IS ISSUED FOR SUSTAINED WIND SPEEDS OF AT LEAST 40 MPH OR GUSTS OF 58 MPH OR MORE.

A HIGH WIND WATCH MEANS THE POTENTIAL EXISTS FOR HAZARDOUS WIND CONDITIONS WITH SUSTAINED WINDS OF AT LEAST 40 MPH OR GUSTS OF 58 MPH OR GREATER. SECURE LOOSE OUTDOOR ITEMS NOW AND STAY TUNED FOR LATER FORECASTS AND POSSIBLE HIGH WIND WARNINGS.

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE GOODLAND KS
411 PM MST SAT FEB 9 2013

COZ091-092-KSZ013-027-041-100015-
CHEYENNE COUNTY CO-KIT CARSON COUNTY CO-SHERMAN KS-GREELEY KS-
WALLACE KS-
411 PM MST SAT FEB 9 2013

.NOW...

STRONG SOUTHERLY WINDS GUSTING TO 50 MPH WILL CONTINUE THROUGH 515 PM MST AND MAY BE LOCALLY ENHANCED BY WEAK SHOWERS MOVING OVER THE AREA. BLOWING DUST WILL ACCOMPANY THESE WINDS...REDUCING VISIBILITY TO UNDER A MILE AT TIMES. THOSE TRAVELING ON INTERSTATE 70 BETWEEN GOODLAND AND STRATTON SHOULD BE READY FOR PERIODS OF CHANGING VISIBILITY.

$$

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE GOODLAND KS
444 PM MST SAT FEB 9 2013

COZ091-092-KSZ013-027-041-100030-
CHEYENNE CO-GREELEY-KIT CARSON-SHERMAN-WALLACE-
INCLUDING THE CITIES OF...BURLINGTON...GOODLAND
444 PM MST SAT FEB 9 2013

.NOW...

...HIGH WIND WARNING IN EFFECT UNTIL 7 PM MST...

VERY STRONG WINDS GUSTING TO 65 MPH WILL SPREAD ACROSS THE AREA OVER THE NEXT HOUR. WINDS WILL SHIFT TO THE WEST SUDDENLY AND WILL ALSO BE ACCOMPANIED BY A PERIOD OF NEAR ZERO VISIBILITY IN BLOWING DUST.

THIS IS A DANGEROUS SITUATION FOR MOTORISTS AS VISIBILITIES WILL RAPIDLY BECOME POOR. USE EXTREME CAUTION IF TRAVELING...ESPECIALLY ON INTERSTATE 70 BETWEEN BURLINGTON AND EDSON THROUGH 530 PM MST.

$$

DODGE CITY NWS

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE DODGE CITY KS
557 PM CST FRI FEB 8 2013

...STRONG SOUTH WINDS EXPECTED AHEAD OF APPROACHING STORM...

.A DEEPENING LOW PRESSURE SYSTEM AND RESULTANT TIGHT PRESSURE GRADIENT SATURDAY WILL RESULT IN STRONG SOUTH WINDS ACROSS ALL OF WESTERN KANSAS.

KSZ043-061>063-074>076-084>086-090800-
/O.EXP.KDDC.WI.Y.0003.000000T0000Z-130209T0000Z/
/O.CON.KDDC.WI.Y.0004.130209T1700Z-130210T0100Z/
SCOTT-HAMILTON-KEARNY-FINNEY-STANTON-GRANT-HASKELL-MORTON-STEVENS-SEWARD-
INCLUDING THE CITIES OF...SCOTT CITY...SYRACUSE...LAKIN...
DEERFIELD...GARDEN CITY...KALVESTA...JOHNSON CITY...ULYSSES...
SUBLETTE...SATANTA...ELKHART...RICHFIELD...HUGOTON...MOSCOW...
LIBERAL...KISMET
557 PM CST FRI FEB 8 2013 /457 PM MST FRI FEB 8 2013/

...WIND ADVISORY REMAINS IN EFFECT FROM 11 AM CST /10 AM MST/ TO 7 PM CST /6 PM MST/ SATURDAY...
...WIND ADVISORY WILL EXPIRE AT 6 PM CST /5 PM MST/ THIS EVENING...

* TIMING...SATURDAY AFTERNOON...ESPECIALLY THE MID AND LATE AFTERNOON HOURS.

* WINDS...WINDS WILL BE SOUTHERLY TO SOUTHWESTERLY AT 25 TO 35 MPH WITH GUSTS TO 45 MPH.

* BLOWING DUST...AREAS OF BLOWING DUST WILL REDUCE VISIBILITY TO BELOW 3 MILES AT TIMES...AND EVEN LOWER ACROSS FAR SOUTHWEST AND WEST CENTRAL KANSAS WHERE AGRICULTURAL FIELDS ARE MORE VULNERABLE GIVEN THE ONGOING DROUGHT.

* IMPACTS...WINDS OF THIS MAGNITUDE WILL MAKE DRIVING DIFFICULT ESPECIALLY...FOR HIGH PROFILE VEHICLES AS THERE WILL BE CROSSWINDS ON EAST TO WEST ROADS.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.

AMARILLO, TX NWS

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE AMARILLO TX
318 PM CST FRI FEB 8 2013

OKZ001-TXZ001-006-011-012-016-017-090530-
/O.NEW.KAMA.WI.Y.0002.130209T1500Z-130210T0300Z/
CIMARRON-DALLAM-HARTLEY-OLDHAM-POTTER-DEAF SMITH-RANDALL-
INCLUDING THE CITIES OF...BOISE CITY...KEYES...DALHART...
HARTLEY...CHANNING...VEGA...AMARILLO...HEREFORD...CANYON
318 PM CST FRI FEB 8 2013

...WIND ADVISORY IN EFFECT FROM 9 AM TO 9 PM CST SATURDAY...

THE NATIONAL WEATHER SERVICE IN AMARILLO HAS ISSUED A WIND ADVISORY...WHICH IS IN EFFECT FROM 9 AM TO 9 PM CST SATURDAY FOR THE WESTERN TEXAS AND OKLAHOMA PANHANDLES AND THE SOUTH CENTRAL TEXAS PANHANDLE.

* EVENT...SUSTAINED SOUTH AND SOUTHWEST WINDS OF 25 TO 35 MPH ARE LIKELY WITH GUSTS TO NEAR 45 MPH MAINLY ACROSS THE WESTERN TEXAS AND OKLAHOMA PANHANDLES AND ALSO THE SOUTH CENTRAL TEXAS PANHANDLE.

* TIMING...STRONG WINDS WILL INCREASE BY LATE MORNING SATURDAY AND CONTINUE THROUGH THE AFTERNOON HOURS AND THEN BEGIN DIMINISHING DURING THE EARLY EVENING HOURS SATURDAY.

* IMPACTS...THE STRONG WINDS WILL MAKE FOR DIFFICULT TRAVEL...ESPECIALLY FOR HIGH PROFILE VEHICLES ON EAST TO WEST ROADS AND HIGHWAYS. LOOSE OUTDOOR OBJECTS SUCH AS TRASH CANS AND TRAMPOLINES CAN BE MOVED OR TOSSED. THE STRONG WINDS WILL ALSO CREATE AREAS OF BLOWING DUST MAINLY ACROSS THE WESTERN SECTIONS OF THE TEXAS AND OKLAHOMA PANHANDLES SATURDAY AFTERNOON AND EARLY EVENING. THE BLOWING DUST WILL RESULT IN REDUCED VISIBILITIES.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WIND ADVISORY MEANS THAT WINDS OF 35 MPH ARE EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.

LUBBOCK, TX NWS

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE LUBBOCK TX
518 AM CST SAT FEB 9 2013

TXZ021>023-027>029-033>035-039-040-092200-
/O.NEW.KLUB.WI.Y.0003.130209T1800Z-130210T0200Z/
PARMER-CASTRO-SWISHER-BAILEY-LAMB-HALE-COCHRAN-HOCKLEY-LUBBOCK-
YOAKUM-TERRY-
INCLUDING THE CITIES OF...FRIONA...BOVINA...DIMMITT...HART...
TULIA...MULESHOE...LITTLEFIELD...OLTON...PLAINVIEW...MORTON...
LEVELLAND...LUBBOCK...SLATON...WOLFFORTH...PLAINS...DENVER CITY...
BROWNFIELD
518 AM CST SAT FEB 9 2013

...WIND ADVISORY IN EFFECT FROM NOON TODAY TO 8 PM CST THIS
EVENING...

THE NATIONAL WEATHER SERVICE IN LUBBOCK HAS ISSUED A WIND
ADVISORY...WHICH IS IN EFFECT FROM NOON TODAY TO 8 PM CST THIS
EVENING.

* TIMING...WINDS WILL INCREASE BY EARLY IN THE AFTERNOON ACROSS
  THE SOUTH PLAINS AND SOUTHWESTERN TEXAS PANHANDLE.

* WINDS...SOUTHWEST TO WEST WINDS WILL INCREASE TO BETWEEN 30 AND
  40 MPH WITH GUSTS TO 55 MPH. SPEEDS WILL DECREASE AFTER SUNSET.

* IMPACTS...TRAVEL WILL BE SEVERELY IMPACTED BY STRONG WINDS.
  LOOSE OUTDOOR OBJECTS SHOULD BE SECURED. THE STRONG WINDS WILL
  ALSO CREATE AREAS OF BLOWING DUST WHICH MAY RESULT IN REDUCED
  VISIBILITIES.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WIND ADVISORY MEANS THAT WINDS OF 35 MPH ARE EXPECTED. WINDS
THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH
PROFILE VEHICLES. USE EXTRA CAUTION.

PUEBLO, CO NWS

URGENT - WINTER WEATHER MESSAGE
NATIONAL WEATHER SERVICE PUEBLO CO
613 PM MST FRI FEB 8 2013

COZ060-068-090700-
/O.CON.KPUB.WS.W.0003.000000T0000Z-130210T1300Z/
EASTERN SAWATCH MOUNTAINS ABOVE 11000 FT-
EASTERN SAN JUAN MOUNTAINS ABOVE 10000 FT-
INCLUDING...INDEPENDENCE PASS...MT ELBERT...MT MASSIVE...
CUMBRES PASS...WOLF CREEK PASS
613 PM MST FRI FEB 8 2013

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL 6 AM MST SUNDAY...

A WINTER STORM WARNING REMAINS IN EFFECT UNTIL 6 AM MST SUNDAY.

* LOCATION...THE EASTERN SAN JUAN MOUNTAINS ABOVE 10000 FEET...
  INCLUDING WOLF CREEK AND CUMBRES PASSES...THE EASTERN SAWATCH
  RANGE ABOVE 11000 FEET...INCLUDING MONARCH PASS.

* CAUSE AND TIMING...A LARGE PACIFIC STORM SYSTEM WILL TRACK FROM
  THE GREAT BASIN INTO NEBRASKA TONIGHT THROUGH SATURDAY NIGHT.
  MOIST SOUTHWEST TO NORTHWEST WINDS ASSOCIATED WITH THIS SYSTEM WILL
  PRODUCE SNOW...HEAVY AT TIMES...THROUGH SATURDAY NIGHT.

* SNOW ACCUMULATION...8 TO 16 INCHES.

* WIND...SOUTHWEST 15 TO 30 GUSTING TO 40 MPH TONIGHT AND SATURDAY
  BECOMING NORTHWEST 15 TO 30 GUSTING TO 40 MPH SATURDAY NIGHT.

* IMPACT...TRAVEL WILL BE HAZARDOUS DUE TO A COMBINATION OF
  SNOW...BLOWING SNOW...POOR VISIBILITIES AND ICY...SNOW COVERED
  ROADS.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

REDUCED VISIBILITIES ARE EXPECTED DUE TO HEAVY SNOW AND BLOWING
SNOW.

AVOID TRAVEL IN THE WARNING AREA. IF YOU ARE PLANNING TO TRAVEL
IN THE WARNING AREA DURING THE TIME OF THE WARNING...LISTEN TO
THE LATEST WEATHER FORECAST AND CONSIDER TRAVELING AT ANOTHER
TIME OR BY ANOTHER ROUTE. IF YOU MUST TRAVEL IN THE WARNING AREA
DURING THE TIME OF THE WARNING...TAKE ALONG A WINTER SURVIVAL
KIT. IF YOU BECOME STRANDED IN A RURAL AREA...STAY WITH YOUR
VEHICLE UNTIL HELP ARRIVES. TO KEEP WARM IN YOUR VEHICLE...RUN
YOUR ENGINE 10 MINUTES EACH HOUR...AND MAKE SURE THE EXHAUST PIPE
IS CLEAR OF SNOW TO AVOID CARBON MONOXIDE POISONING.

BOULDER, CO NWS

URGENT - WINTER WEATHER MESSAGE
NATIONAL WEATHER SERVICE DENVER/BOULDER CO
532 AM MST SAT FEB 9 2013

...WINTER STORM WILL MOVE ACROSS NORTHERN COLORADO THIS AFTERNOON THROUGH SUNDAY...

.A STRONG WINTER STORM SYSTEM WILL MOVE ACROSS COLORADO FROM THIS AFTERNOON THROUGH SUNDAY. PERIODS OF LIGHT TO MODERATE SNOW WILL DEVELOP OVER THE MOUNTAINS LATER TODAY AND THEN CONTINUE TONIGHT. ON THE NORTHEAST COLORADO PLAINS...A DEEP SURFACE LOW WILL DEVELOP OVER EASTERN COLORADO TODAY AND MOVE INTO NORTHWESTERN KANSAS BY SUNDAY MORNING WITH STRONG WINDS DEVELOPING ACROSS THE PLAINS TONIGHT. OVER THE NORTHEAST CORNER OF THE STATE...FALLING SNOW WILL COMBINE WITH STRONG WINDS OVERNIGHT TO PRODUCE BLIZZARD CONDITIONS THAT WILL MAKE TRAVEL DIFFICULT.

COZ048-050-051-092245-
/O.UPG.KBOU.BZ.A.0001.130210T0000Z-130211T0000Z/
/O.NEW.KBOU.BZ.W.0001.130210T0000Z-130211T0000Z/
LOGAN COUNTY-SEDGWICK COUNTY-PHILLIPS COUNTY-
INCLUDING THE CITIES OF...CROOK...MERINO...STERLING...PEETZ...
JULESBURG...OVID...SEDGWICK...AMHERST...HAXTUN...HOLYOKE
532 AM MST SAT FEB 9 2013

...BLIZZARD WARNING IN EFFECT FROM 5 PM THIS AFTERNOON TO 5 PM MST SUNDAY...

THE NATIONAL WEATHER SERVICE IN DENVER HAS ISSUED A BLIZZARD WARNING...WHICH IS IN EFFECT FROM 5 PM THIS AFTERNOON TO 5 PM MST SUNDAY. THE BLIZZARD WATCH IS NO LONGER IN EFFECT.

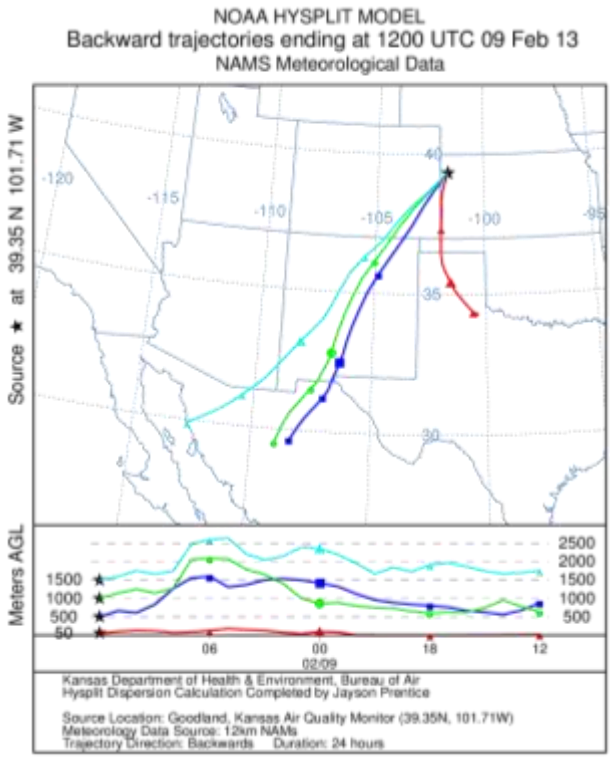
* TIMING...RAIN AND SNOW SHOWERS WILL DEVELOP OVER NORTHEAST COLORADO LATE THIS AFTERNOON AND CHANGE TO ALL SNOW IN THE EVENING. NORTH TO NORTHWEST WINDS WILL INCREASE OVERNIGHT...CAUSING BLOWING AND DRIFTING SNOW TO DEVELOP. THE SNOW WILL DECREASE FROM WEST TO EAST ON SUNDAY...BUT STRONG WINDS MAY CONTINUE TO PRODUCE BLIZZARD CONDITIONS...ESPECIALLY EAST OF STERLING.

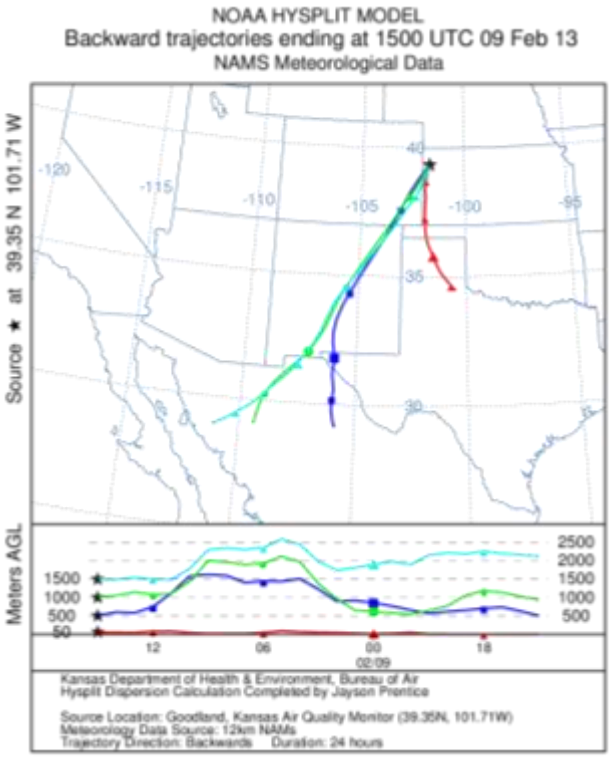
* SNOW ACCUMULATIONS...4 TO 8 INCHES POSSIBLE...MAINLY TONIGHT.

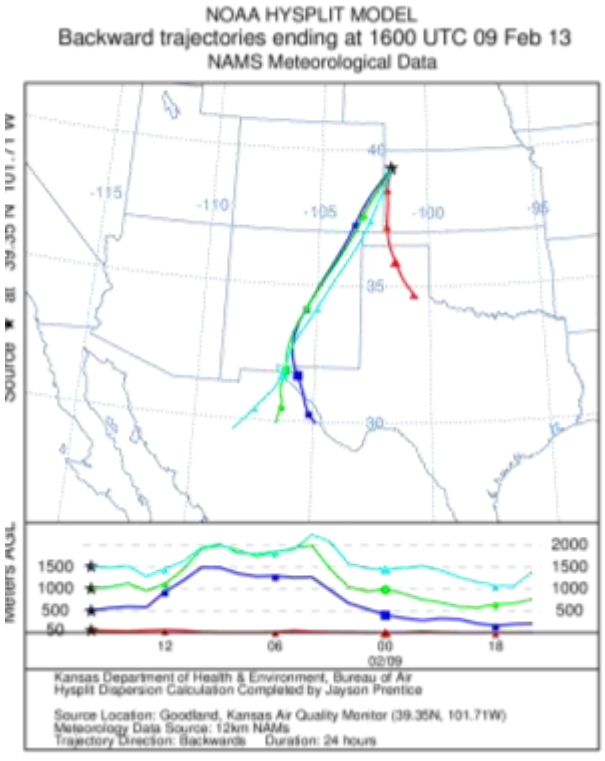
* WIND/VISIBILITY...NORTH WINDS 15 TO 25 MPH WITH GUSTS TO AROUND 40 MPH SATURDAY NIGHT. NORTHWEST WINDS AT 25 TO 35 MPH WITH GUSTS TO AROUND 50 MPH ON SUNDAY. VISIBILITIES COULD BE RESTRICTED TO LESS THAN A QUARTER MILE AT TIMES.

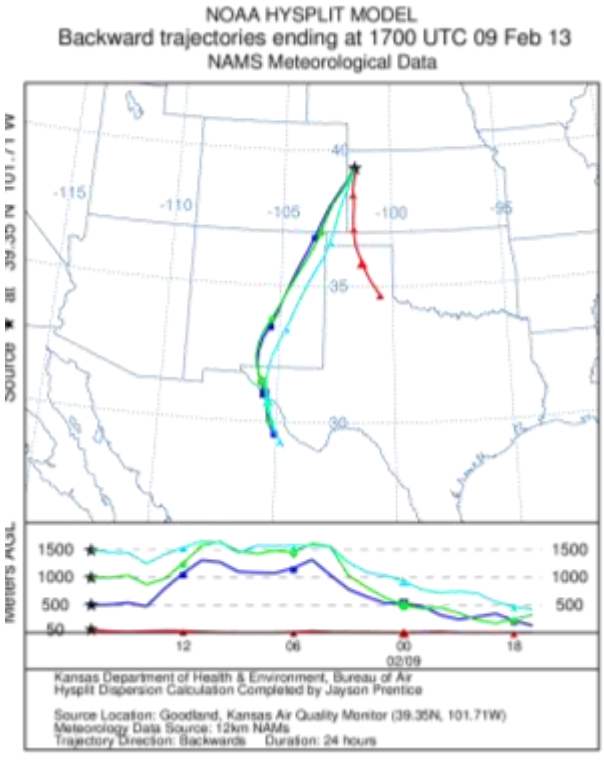
* IMPACTS...POOR VISIBILITIES DUE TO BLOWING SNOW WILL MAKE TRAVEL HAZARDOUS. DRIFTING OF SNOW MAY MAKE RURAL ROADS IMPASSABLE.

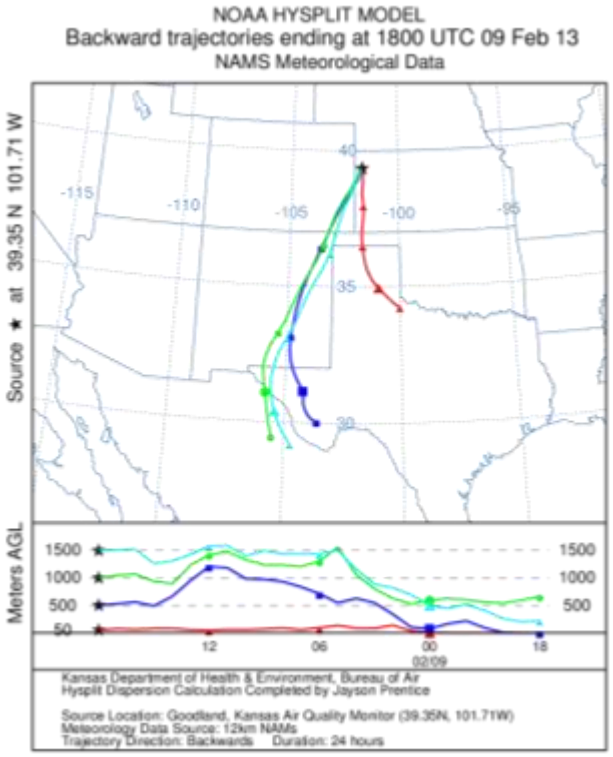
11. Appendix C - Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) Runs for Goodland,KS on 9 February 2013

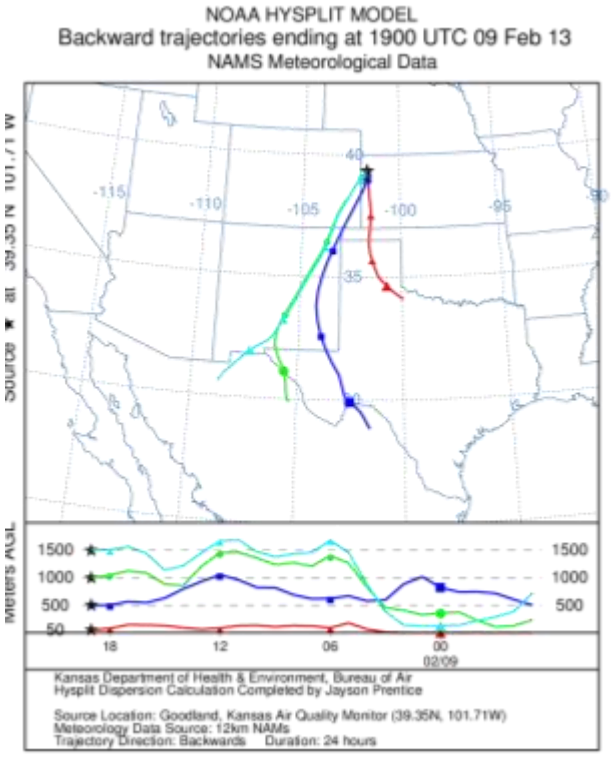


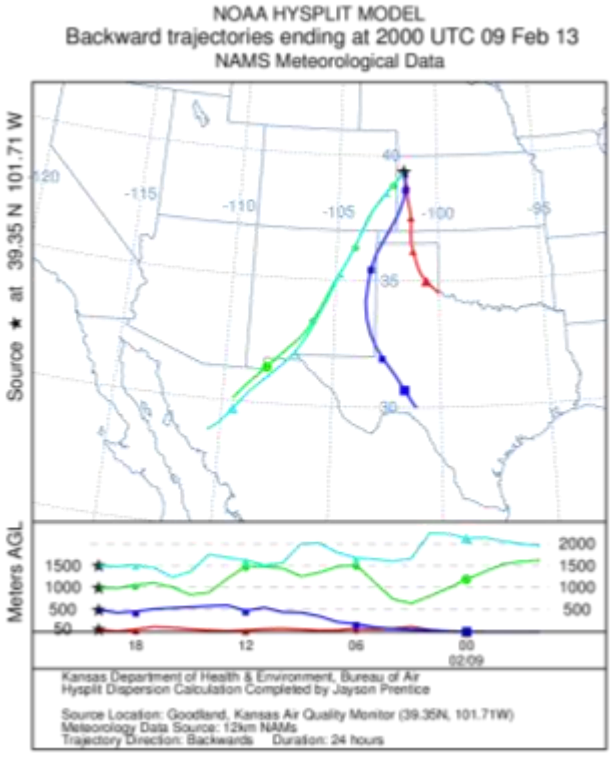


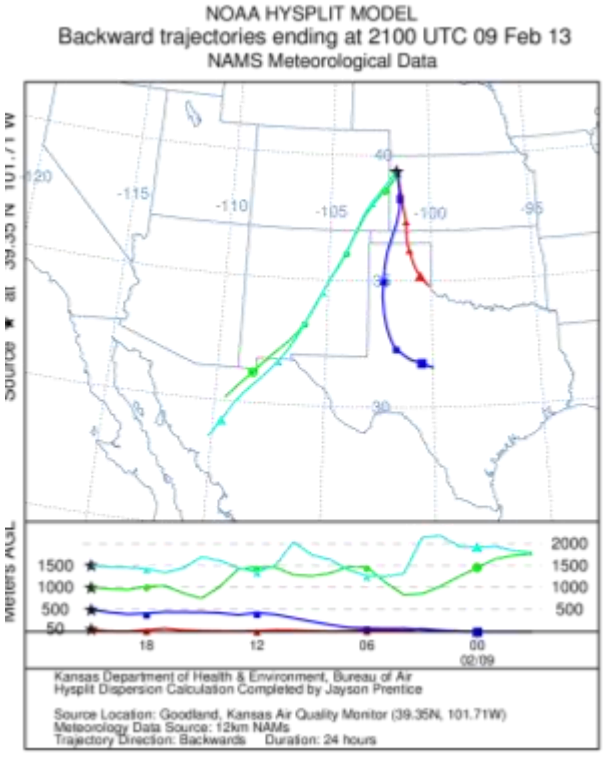


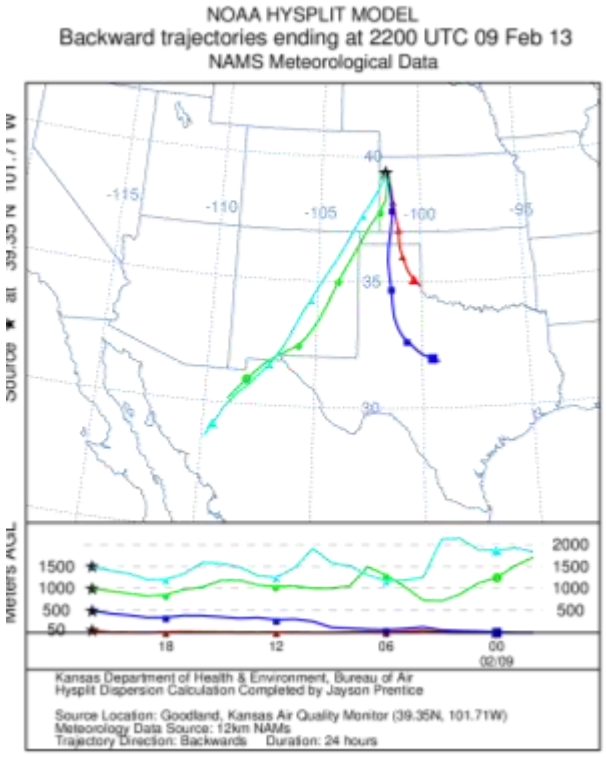


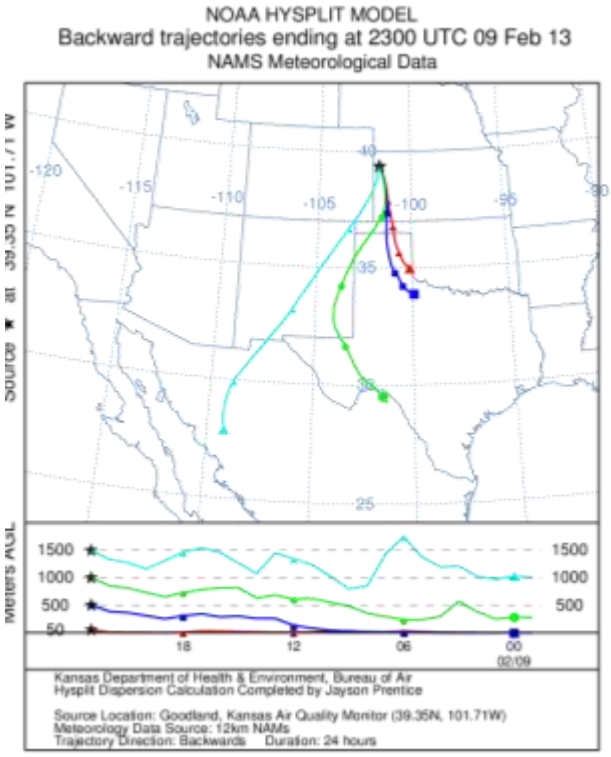

NOAA HYSPLIT MODEL
Backward trajectories ending at 1800 UTC 09 Feb 13
NAMS Meteorological Data
Source ★ at 39.35 N 101.71 W
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours

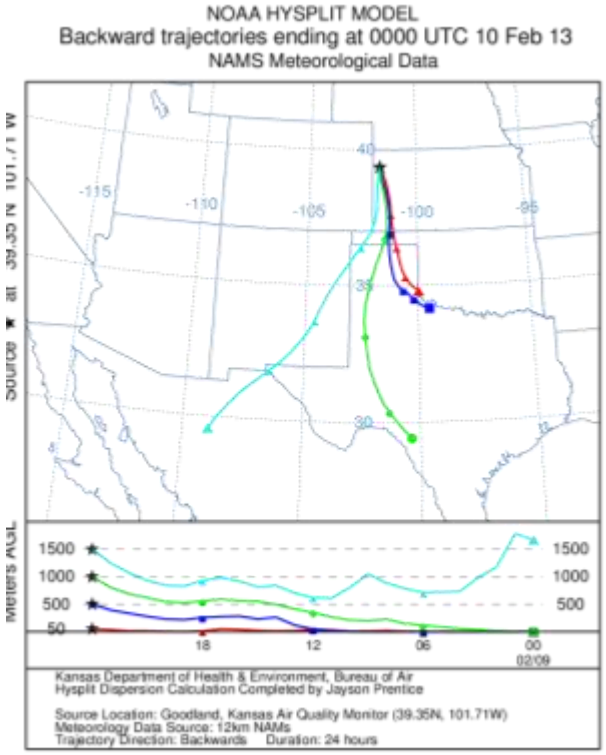

NOAA HYSPLIT MODEL
Backward trajectories ending at 1900 UTC 09 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours

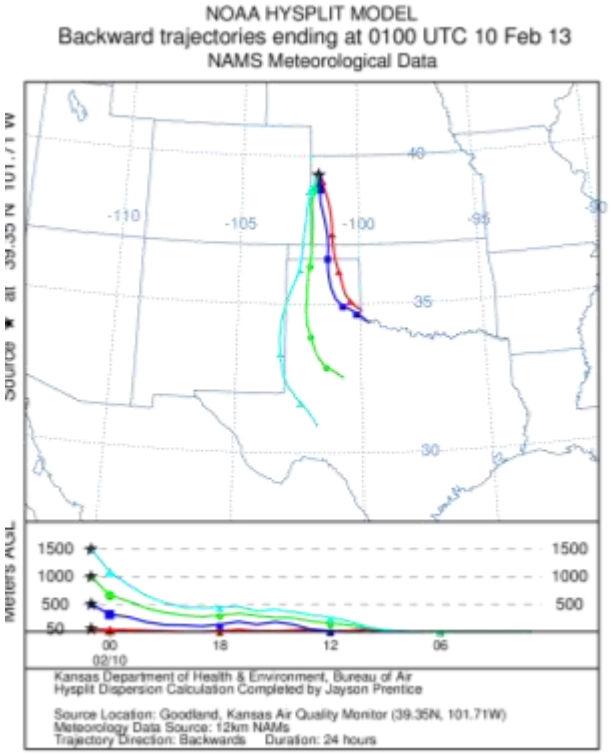

NOAA HYSPLIT MODEL
Backward trajectories ending at 2000 UTC 09 Feb 13
NAMS Meteorological Data
Source ★ at 39.35 N 101.71 W
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours


NOAA HYSPLIT MODEL
Backward trajectories ending at 2100 UTC 09 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours


NOAA HYSPLIT MODEL
Backward trajectories ending at 2200 UTC 09 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours


NOAA HYSPLIT MODEL
Backward trajectories ending at 2300 UTC 09 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours


NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 10 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours


NOAA HYSPLIT MODEL
Backward trajectories ending at 0100 UTC 10 Feb 13
NAMS Meteorological Data
Meters AGL
Kansas Department of Health & Environment, Bureau of Air
Hysplit Dispersion Calculation Completed by Jayson Prentice
Source Location: Goodland, Kansas Air Quality Monitor (39.35N, 101.71W)
Meteorology Data Source: 12km NAMs
Trajectory Direction: Backwards Duration: 24 hours

12. Appendix D – Newspaper Accounts of February 9, 2013 Dust Storm

12D The Burlington Record, Burlington, Colorado
Thursday, February 14, 2013

Terrible, nasty wind hit the eastern plains of Colorado last Friday and Saturday, kicking up the dust and dirt. Jason Steerman took this photo on Saturday evening with the dirt all but blocking out the sun. The sky was a brown color and at times by some fields, visibility was less than 100 feet.

High winds on Saturday, Feb. 9, took down the Denny's sign by the interstate, crashing onto a trailer in the parking lot. The driver was sleeping inside the cab when he was awakened by the crash.

13. Appendix E – 1998 State of Kansas PM_{10} Natural Events Action Plans (NEAP) for Morton and Sedgwick Counties

STATE OF KANSAS PM_{10} NATURAL EVENTS ACTION PLANS
(NEAP)
FOR MORTON AND SEDGWICK COUNTIES

Revision 0
1 May 1998

Kansas Department of Health and Environment
Division of Environment
Bureau of Air and Radiation
Forbes Field, Building 283
Topeka, KS 66620

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FORWARD

During the first calendar quarter of 1996, high winds coupled with extremely dry soil conditions caused exceedances of the National Ambient Air Quality Standard (NAAQS) for PM_{10} (airborne particulate matter having a nominal aerodynamic diameter less than or equal to 10 microns) then in effect. In May 1996, the United States Environmental Protection Agency (EPA) issued a Natural Events Policy memorandum to address such exceedances resulting from natural events. This policy is applicable to emissions caused by natural events since 1 January 1994. Although these events occurred prior to issuance of the policy memorandum, EPA has required, via retroactive implementation, preparation of Natural Events Action Plans for the affected areas in Kansas (i.e., Morton and Sedgwick counties).

Prior to the Natural Events Policy memorandum, natural events were treated together with other "exceptional events", and documented exceedances due to high winds were "flagged" with a "High Winds" code when submitted to the Aerometric Information Retrieval System (AIRS). Concurrence was obtained from EPA after completion of their review of documentation. For regulatory purposes, the use of flagged data associated with an exceptional event was considered on a "case-by-case" basis.

Current federal policy requires preparation and implementation of a Natural Events Action Plan (NEAP) for each area affected by naturally-caused exceedances of the NAAQS for PM_{10}. Documented exceedances due to high winds are flagged with a "High Winds" code upon submission to AIRS, and EPA concurrence is required. Subsequent to EPA concurrence, exceedances due to natural events are excluded from NAAQS attainment status determinations, provided that a NEAP is implemented within the time frame established by the policy memorandum. Failure to prepare a NEAP will result in redesignation of affected areas as nonattainment, and the State will also be required to adopt a federally-enforceable revision of its State Implementation Plan (SIP).

This document contains separate, but similar, PM_{10} Natural Events
Action Plans for Morton and Sedgwick counties in the state of Kansas. Each of these plans is a free-standing document, subject to independent review and revision. For this reason, each plan (designated as "NEAP Part I" and "NEAP Part II") includes a separate Signatures/Approvals page and its own Table of Contents.

Appendices at the end of this document contain information relevant to blowing dust (i.e., high levels of PM_{10}) associated with high wind events. This information is essential to an understanding of the frequency and magnitude of PM_{10} high wind events on the Great Plains.

A special thank you is included here for the assistance provided by Dr. Ed Skidmore and his staff at the United States Department of Agriculture - Agricultural Research Service (USDA-ARS) Wind Erosion Research Unit (WERU) located at Kansas State University (KSU). The WERU exists because there is much more to this problem than dust in the atmosphere.

PREAMBLE

During the background review of high wind events for preparation of a Natural Events Action Plan (NEAP) for Morton and Sedgwick Counties, similarities between recent events and those of the Dust Bowl era were evident. Information obtained from the United States Department of Agriculture - Agricultural Research Service (USDA-ARS) Wind Erosion Research Unit (WERU) located at Kansas State University (KSU) provides verification that events frequently occur across the Great Plains which closely resemble those which caused the Dust Bowl. These events continue to occur in spite of significant expenditures of public funds directed at their prevention.

In southwestern Kansas, as well as throughout much of the Great Plains, February, March, and April have long been referred to as "the blow months" because this period consistently brings the winds of the highest velocities. High winds in this region often begin in the latter half of January, and sometimes continue well into the month of May.

A prolonged drought, lasting from 1932 through 1938, was the basic cause of the Dust Bowl; this period is still referred to by many residents of the Great Plains as "the Dirty Thirties". Successive failures of the winter wheat crop and drought damage to vegetation on untilled land left large expanses of dry topsoil exposed. Beginning in the spring of 1932, the Dust Bowl eventually grew to encompass an area covering approximately 97 million acres, including most of the Texas and Oklahoma panhandles, northeastern New Mexico, southeastern Colorado, and southwestern Kansas. Damage extended northward as far as the Dakotas. The "blow area", where wind erosion was the worst, centered on the area between Goodwell, Oklahoma and Liberal, Kansas. By the mid-1930s, the "blow area" had expanded to include some 50 million acres, much of it in southwestern Kansas.

One of the most effective strategies employed by the federal government during and following the Dirty Thirties was removal of land from cultivation. This strategy was initially focused on tracts of "submarginal" land (i.e., land with poor crop yield potential), and was employed in southwestern Kansas. Morton County, Kansas, was the most severely damaged county in the United States during the Dust Bowl. The federal government purchased an expanse of land that was considered submarginal, but had been planted in winter wheat during the Great Depression as crop prices fell and the drought intensified. During the Dust Bowl, this land was thus deliberately taken out of production in an attempt to reestablish grassland and prevent continued wind erosion. It has been designated as the Cimarron National Grassland since 1960.

Other federal programs were initiated which actually paid farmers to take land out of production. Over the years, these programs evolved into the Conservation Reserve Program (CRP). This program offers payments to farmers for maintaining qualifying tracts of land in grass. It is no random coincidence that there are both a National Grassland and a very large allotment of CRP land in southwestern Kansas.

With the return of more normal annual precipitation and the outbreak of the Second World War, massive agricultural expansion took place during the 1940s. Drought returned in the 1950s, and so did uncontrollable blowing dust. This drought, which ended in the spring of 1957, prompted farmers in

southwestern Kansas to turn to irrigation.

Recently proposed changes in the CRP prompted the Kansas Department of Health and Environment, Bureau of Air and Radiation (KDHE/BAR), to initiate ambient air quality monitoring for particulate matter in southwestern Kansas. With the threat of CRP acreage being brought back under the plow, a special study was initiated in order to obtain background particulate data. One of the KDHE/BAR monitoring sites was located on the Cimarron National Grassland near Elkhart, in Morton County, Kansas. Another KDHE/BAR monitoring site was located near the town of Richfield, also in Morton county. An exceedance of the 24 hour PM_{10} standard occurred at the Richfield site during the "blow months" of 1996, and the U.S. Environmental Protection Agency (EPA) subsequently required filing of a NEAP for Morton County. It should be noted that the CRP was not changed as proposed, and that the special study has been discontinued until CRP land reverts to crop production.

Information provided by the WERU indicates that blowing dust was
a widespread problem across Kansas during the first quarter of 1996. This is confirmed by the information concerning drought conditions and particulate concentrations in Appendix B. Some of this dust was blown into the state from southeastern Colorado and the Oklahoma panhandle. The regional nature of these events is documented in photographs contained in Appendix A. Exceedances of the 24 hour PM_{10} standard recorded in the Wichita-Sedgwick County area in January and March (Appendix B, newspaper clippings) were also due to blowing dust, some of which blew in from northern Oklahoma. Dust clouds were observed as far away as Tuttle Creek Reservoir near Manhattan, in the northeast quadrant of Kansas. This information emphasizes that Kansas is faced with a regional problem from which a NEAP will never provide relief; localized controls alone will be of limited effectiveness in solving the problem. The regional nature of the problem of wind erosion in the Great Plains is also clearly evident in the wind erosion map which appears in Appendix C.

Wind erosion damage to the soil remains a significant problem. Over half of the 284 million acres of cropland in the United States is designated as "highly erodible" land. It is estimated that approximately 5 million acres of land are moderately to severely damaged by wind erosion annually. This amount is expected to increase if the 35 million acres of CRP land are brought back into agricultural production.

Soil conservation efforts have indeed reduced soil erosion rates across the Great Plains, but there are good years, and there are bad years. The potential for blowing dust ALWAYS exists in southwestern Kansas. Although federal agencies such as the U. S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (and their state and local implementing partnerships) are responsible for soil conservation efforts and have made significant progress over the last sixty years, no complete solution to the problem has been achieved. After soil has begun to move, virtually nothing can be done to stop it until the winds cease. This is the full-time challenge that the WERU and the entire agricultural community face, and they are better equipped to work at it than either KDHE or EPA. The wind still blows in the Dust Bowl, and when combined with drought and sparse vegetation, dust storms still occur.

STATE OF KANSAS PM_{10} NATURAL EVENTS ACTION PLAN
(NEAP)
FOR MORTON COUNTY

NEAP Part I

Revision 0
1 May 1998

Kansas Department of Health and Environment
Division of Environment
Bureau of Air and Radiation
Forbes Field, Building 283
Topeka, KS 66620

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0 SIGNATURES/APPROVALS

Originating Unit: _____ (Signature, Author)

_____

(Date)

Air Monitoring Services Section: _____ (Signature, Section Chief)

_____

(Date)

Air Planning and Assessment Section:_____
(Signature, Section Chief)

_____

(Date)

Bureau of Air and Radiation: _____
(Signature, Bureau Director)

_____

(Date)

Southwest District Office: _____
(Signature, DEA)

_____

(Date)

Division of Environment: _____
(Signature, Director)

_____

(Date)

1 INTRODUCTION

1.1 Purpose and Scope of Plan

The United States Environmental Protection Agency (EPA) and Kansas Department of Health and Environment, Bureau of Air and Radiation (KDHE/BAR), recognize that the ability to control PM_{10} (airborne particulate matter having a nominal aerodynamic diameter less than or equal to 10 microns)is severely limited during certain natural events. In May 1996, EPA issued a Natural Events Policy to address such situations. This document has been developed in accordance with EPA's policy, and presents the Natural Events Action Plan (NEAP) for an area within the state of Kansas affected by PM_{10} exceedances of the National Ambient Air Quality Standard (NAAQS) due to natural events. The United States Environmental Protection Agency has identified three categories of natural events affecting the PM_{10} NAAQS: 1) volcanic and seismic activity, 2) wildland fires, and 3) high wind events.

Of the categories listed above, high wind events are the most probable to cause PM_{10} to exceed the NAAQS in Kansas. This plan is intended to address ambient PM_{10} concentrations in Kansas due to dust raised by unusually high winds. Such events will be considered natural events if the dust: 1) originated from nonanthropogenic sources, or 2) originated from anthropogenic sources controlled with best available control measures (BACM).

This plan has been specifically prepared in response to high wind events which occurred in Morton County, Kansas, near the town of Richfield, in January of 1996, when high winds coupled with extremely dry conditions raised dust into the atmosphere. These uncontrollable natural high wind events resulted in one exceedance of the 24-hour standard then in effect for PM_{10}. Documentation of these events is provided in Appendix B.

1.2 The 24-Hour National Ambient Air Quality Standard (NAAQS) for PM_{10}

The EPA considers the ambient air quality to be unhealthy when the 24-hour PM_{10} NAAQS is exceeded. The short-term PM_{10} NAAQS is exceeded when the 24-hour average concentration is greater than 150 micrograms per cubic meter (ug/m3). The 24-hour NAAQS is violated when the expected number of days per calendar year with a 24-hour average concentration above 150 ug/m3 is greater than 1.0, as determined by procedures described in Appendix K of 40 CFR 50.

1.3 Definition of High Winds for PM_{10} Natural Events

The definition of high winds for the purpose of this plan shall be as follows:

A daily averaged wind speed greater than 20 miles per hour (mph) or an hourly averaged wind speed greater than 25 mph or gusts greater than 40 mph with no precipitation, or only a trace of precipitation (i.e., scattered drops that do not completely wet or cover an exposed area up to a rate of 0.01 inch per

hour).*

* A general wind threshold for raising of dust is considered to be 6 meters per second, equivalent to a wind speed of 13.4 mph. The actual threshold will vary with soil type, moisture, etc.

According to the Beaufort Wind Strength Scale, a Force 4 ("Moderate Breeze") is equivalent to a wind speed of 13-18 mph. (It should be noted that average annual wind speeds in southwestern and south central Kansas fall within the range of 10 - 15 mph.) It is defined as the wind strength at which dust and paper are raised from the ground. A daily averaged wind speed of 20 mph could thus be reasonably considered to continue to raise and also maintain blowing dust in the atmosphere.

A Force 6 ("Strong Breeze") is equivalent to a wind speed of 25-31 mph. It is defined as the wind strength at which large tree branches move and open wires begin to whistle. An hourly averaged wind speed of 25 mph could be reasonably considered to continue to raise and also maintain blowing dust in the atmosphere.

2 PUBLIC EDUCATION AND NOTIFICATION

2.1 Identification of Individuals Most at Risk

The following persons are usually considered to be most at risk for adverse health effects from inhalation of airborne particulate matter, and thus comprise the target population of this plan:

1) Children;
2) elderly persons;
3) individuals with impaired pulmonary function,
    a) asthma;
    b) chronic bronchitis; and
    c) chronic obstructive pulmonary disease (COPD; i.e., emphysema);
4) individuals with cardiovascular disease; and
5) immunosuppressed persons.

2.2 Implementation of Education and Notification

The EPA Natural Events Policy requires public education concerning natural events. It also requires that the public must be informed whenever a natural event is imminent. EPA's Natural Events Policy memorandum states that the air quality is considered unhealthy whenever the 24-hour PM_{10} NAAQS is exceeded. Advance public notification concerning an imminent dust storm will require an accurate forecasting procedure. Since no such procedure is presently known to KDHE/BAR, it is not feasible to commit to such notification except through annual general notices.

In order to facilitate future implementation of a forecasting method and subsequent development and implementation of a public health advisory mechanism, EPA is encouraged to commit resources to relevant research. To promote timely development of such a system, KDHE/BAR are committed to support any organization in their request for EPA funding for relevant research, and to assist in evaluation of potential methods for applicability to dust storms affecting Kansas. Organizations interested in such research exist. Any forecasting/public health advisory system that proves to be both reliable and cost-effective will be considered by KDHE/BAR.

This NEAP addresses the following educational goals:

1) Educate the public about the harmful health effects of high concentrations of PM_{10}; and
2) Inform the public that certain types of natural events may affect the air quality of a given area.

These public education goals will be addressed on an annual basis through public service announcements. For this purpose, the Southwest District Office of KDHE (KDHE/SWDO) will issue the following statement for publication in Morton County newspapers during January of each year:

PUBLIC NOTICE
OF
POTENTIAL ADVERSE HEALTH EFFECTS ASSOCIATED
WITH ELEVATED LEVELS OF AIRBORNE DUST

On 28 January 1996, the Kansas Department of Health and Environment (KDHE) measured elevated levels of particulate matter in the air in Morton County, Kansas. Subsequent evaluation of this occurrence has been conducted by KDHE, and has clearly demonstrated the cause to be blowing dust associated with high winds and dry soil conditions.

During dry conditions in Kansas, there is a potential for blowing dust associated with high winds. The amount of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) contained in this blowing dust may exceed the National Ambient Air Quality Standard (NAAQS) and reach levels high enough to cause adverse health effects when inhaled. Children, elderly persons, immunosuppressed persons, and individuals with impaired respiratory and/or cardiovascular function are particularly susceptible to the adverse health effects associated with inhalation of airborne particulate matter. During natural high wind events which generate high levels of airborne particulate matter, it is advisable to limit outdoor activities and remain indoors with doors and windows closed as much as possible.

During periods of blowing dust, it is also recommended that excessive physical exertion and exposure to tobacco smoke and other respiratory irritants be avoided. Persons taking regular medications are advised to ensure that they have at least a five-day supply on hand. Individuals with chronic medical conditions should consider contacting a health care provider at the onset of any of the following symptoms: headache, repeated coughing, wheezing, chest tightness or pain, difficulty in breathing, excessive phlegm production, or nausea. It is suggested that all individuals avoid vigorous outdoor activity.

This notice is applicable when local weather forecasts indicate a possibility of high winds (sustained winds above 20 miles per hour (mph) or gusts greater than 40 mph without precipitation) in the local area.

This notification is being issued by KDHE as a public service and to assure compliance with the U. S. Environmental Protection Agency's policies related to the protection of public health in areas affected by elevated levels of particulate matter due to natural events. Questions regarding this notice should be directed to the Kansas Department of Health and Environment, Southwest District Office at (316) 225-0596.

3 ABATEMENT OR MINIMIZATION OF CONTROLLABLE SOURCES OF PM_{10}

3.1 Potential Sources of PM_{10} During High Wind Events

The following have been identified as potential sources of blowing dust during high wind events in Kansas. Omission of a source from this list does not preclude its future identification as a potential source.

a) Tilled agricultural land;
b) sparsely vegetated or overgrazed range land;
c) unpaved roads and parking lots;
d) urban paved roads; and
e) construction sites

3.2 Identification and Application of Best Available Control Measures (BACM)

The Natural Events Policy issued by EPA provides for identification and application of Best Available Control Measures (BACM) to sources of soil that have been disturbed by anthropogenic activities. Determination of BACM should follow EPA's technical guidance for the determination of BACM for fugitive dust sources contained in the Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures, EPA-450/2-92-004, September 1992. These BACM will be evaluated by KDHE/BAR in consultation with KDHE/SWDO.

3.2.1 Use of conservation farming practices on agricultural lands

The following have been identified as standard soil conservation measures which constitute agricultural BACM. Omission of any soil conservation measure from this list does not preclude its evaluation and application in the future.

a) Reduced tillage farming practices;
b) tree rows;
c) other physical windbreaks;
    1) grass barriers;
    2) annual (e.g., sunflower) barriers;
    3) buffer strips; and
    4) "snow" fences;
d) cover crops;
e) strip cropping;
f) crop residues; and
g) emergency tillage

3.2.2 Abatement and suppression of dust from other sources

The following have been identified as measures which can be employed for mitigation of blowing dust from other sources. Omission of any measure from this list does not preclude its evaluation and application in the future.

a) Application of chemical dust suppressants to unpaved roads, parking lots, and open areas with exposed soil;
b) wet vacuuming of urban paved roads and parking lots;
c) dust suppression at construction sites,
    1) water spraying of exposed soil;
    2) application of chemical dust suppressants; and
    3) use of surface coverings; and
d) restriction/prohibition of off-road vehicle activities

3.3 Undefined BACM

If appropriate BACM are not defined for contributing anthropogenic sources in question, KDHE/BAR should attempt to identify specific measures for implementation. This will be accomplished in two phases, 1) identification of potential mitigating measures, and 2) initial implementation by means of pilot tests for evaluation of the effectiveness of the measures.

3.3.1 Mitigating Measures

Soil erosion specialists at the federal and state levels have been working for approximately sixty years to develop and evaluate potential mitigating measures. These soil conservation experts continue to implement measures that prove effective for the reduction or prevention of blowing dust.

Numerous measures have been applied and are currently in place across the Great Plains in order to minimize the effects of wind erosion. The United States Department of Agriculture - Agricultural Research Service (USDA-ARS) Wind Erosion Research Unit (WERU) located at Kansas State University (KSU) has achieved the following:

a) Evaluated emergency till practices and demonstrated their effectiveness in halting wind erosion as it started;
b) Evaluated vegetative and non-vegetative mulches and demonstrated that standing vegetation can be five to ten times more effective at reducing wind erosion than material laying flat;
c) Evaluated the relative effectiveness of different plant species in windbreaks;
d) Established the use of feedlot wastes as an effective method for erosion control; and
e) Established the use of permanent grass wind barriers and annual crop control strips, and evaluated the relative effectiveness of their spacing, position, and size in reducing wind erosion.

3.3.2 Pilot Tests

Pilot testing and evaluation of experimental measures continue to be conducted by soil erosion specialists. These federally funded research efforts, which include experimental evaluation of erosion abatement, control, and prevention techniques, continue throughout the Great Plains.

3.4 Evaluation of BACM

The area south and southwest of Richfield, extending into northwestern Oklahoma and southeastern Colorado, is natural grassland and farmland, much of which is planted in wheat. During the first quarter of 1996, this area was experiencing drought conditions (Appendix B). The drought-induced decrease in vegetative cover due to dry grassland and poor germination of the winter wheat crop resulted in increased exposure of topsoil. As a result of the freezing and thawing of increasingly dry topsoil, bare areas were covered with a layer of fine loose granules (crustal dust).

It is recognized that the Richfield, Morton County area was influenced by high winds and blowing dust from the south and southwest on the day of the recorded PM_{10} exceedance. Considering the wind speeds and gusts noted during the day that the concentration above the 24-hour NAAQS was recorded (Appendix B, Table 3), it is apparent that these conditions were abnormal. The phenomena which gave rise to these blowing dust problems were, therefore, natural events which could not be prevented by application of BACM. With the top few inches of soil loose, and the lower portion frozen, the farming community was unable to apply emergency tillage or other measures to aid in the reduction of blowing dust. In fact, it is likely that these events occurred in spite of general area-wide application of accepted good agricultural soil conservation practices.

After the recorded exceedance, a fire, which had been attributed to downed power lines in the Oklahoma panhandle, spread into southwestern Kansas and destroyed vegetation across a very large expanse of CRP land. Wind erosion of soil in southwestern Kansas continued through the month of May.

On the basis of these findings, KDHE has concluded that the Richfield (population 47; 1997 Kansas estimate) area or Morton County (population 3399; 1997 Kansas estimate) could not have prevented these exceedances at the recorded particulate levels by employing localized urban control measures. The increase in PM_{10} concentration on the day of the recorded exceedance was 549% above normally observed levels. The 28 January value of 203 ug/m^3 at the monitoring site (3.25 miles north of Richfield) does not relate to the quarterly mean of 37 ug/m^3 at that site (Appendix B, Table 2).

3.5 Implementation Strategy

In view of the apparent regional nature of this problem, it seems clear that no single state agency has the resources or regional coverage required to increase the effectiveness of established soil erosion programs. The impact of implementation of short-term, localized control measures at the state level would be

negligible when faced with the combination of conditions that resulted in the elevated levels of PM_{10} described in this plan. To be effective in reducing such dust excursions at their source, a regional systems approach which includes consideration of factors such as cropping patterns, soil types, and climatological information must be implemented. KDHE will be working closely with USDA representatives in Kansas to emphasize the continued importance of regional efforts coordinated through federal, state, and local actions directed at reducing soil erosion. Concurrently, KDHE will continue to assure that the public is aware of the potential health consequences of elevated levels of airborne particulate.

4 PERIODIC REVIEW OF NATURAL EVENTS ACTION PLAN (NEAP)

This Natural Events Action Plan will be reviewed by KDHE/BAR in conjunction with KDHE/SWDO at least once in every five years. The focus of this review will be the re-evaluation of conditions causing exceedances and violations of the NAAQS for PM_{10}. The review will also consider the implementation status of the plan, as well as the adequacy of actions taken. A Periodic Review Report will be prepared by KDHE/BAR in order to summarize the findings of the review process.

STATE OF KANSAS PM_{10} NATURAL EVENTS ACTION PLAN
(NEAP)
FOR SEDGWICK COUNTY

NEAP Part II

Revision 0
1 May 1998

Kansas Department of Health and Environment
Division of Environment
Bureau of Air and Radiation
Technical Services Section
Forbes Field, Building 283
Topeka, KS 66620

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0 SIGNATURES/APPROVALS

Originating Unit: _____ (Signature, Author)

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(Date)

Air Monitoring Services Section: _____ (Signature, Section Chief)

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(Date)

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(Signature, Section Chief)

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(Date)

Bureau of Air and Radiation: _____
(Signature, Bureau Director)

_____
(Date)

Wichita-Sedgwick County
Department of Community Health: _____
(Signature, Director)

_____ (Date)

Division of Environment: _____
(Signature, Director)

_____
(Date)

1 INTRODUCTION

1.1 Purpose and Scope of Plan

The United States Environmental Protection Agency (EPA), Wichita-Sedgwick County Department of Community Health (WSCDCH), and Kansas Department of Health and Environment, Bureau of Air and Radiation (KDHE/BAR), recognize that the ability to control PM_{10} (airborne particulate matter having a nominal aerodynamic diameter less than or equal to 10 microns)is severely limited during certain natural events. In May 1996, EPA issued a Natural Events Policy to address such situations. This document has been developed in accordance with EPA's policy, and presents the Natural Events Action Plan (NEAP) for an area within the state of Kansas affected by PM_{10} exceedances of the National Ambient Air Quality Standard (NAAQS) due to natural events. The United States Environmental Protection Agency has identified three categories of natural events affecting the PM_{10} NAAQS: 1) volcanic and seismic activity, 2) wildland fires, and 3) high wind events.

Of the categories listed above, high wind events are the most probable to cause PM_{10} to exceed the NAAQS in Kansas. This plan is intended to address ambient PM_{10} concentrations in Kansas due to dust raised by unusually high winds. Such events will be considered natural events if the dust: 1) originated from nonanthropogenic sources, or 2) originated from anthropogenic sources controlled with best available control measures (BACM).

This plan has been specifically prepared in response to high wind events which occurred in Sedgwick County, Kansas in January and March of 1996, when high winds coupled with extremely dry conditions raised dust into the atmosphere. These uncontrollable natural high wind events resulted in exceedances of the 24-hour standard then in effect for PM_{10}. Documentation of these events is provided in Appendix B.

1.2 The 24-Hour National Ambient Air Quality Standard (NAAQS) for PM_{10}

The EPA considers the ambient air quality to be unhealthy when the 24-hour PM_{10} NAAQS is exceeded. The short-term PM_{10} NAAQS is exceeded when the 24-hour average concentration is greater than 150 micrograms per cubic meter (ug/m3). The 24-hour NAAQS is violated when the expected number of days per calendar year with a 24-hour average concentration above 150 ug/m3 is greater than 1.0, as determined by procedures described in Appendix K of 40 CFR 50.

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The definition of high winds for the purpose of this plan shall be as follows:

A daily averaged wind speed greater than 20 miles per hour (mph) or an hourly averaged wind speed greater than 25 mph or gusts greater than 40 mph with no precipitation, or only a trace of precipitation (i.e., scattered drops that do not completely wet or cover an exposed area up to a rate of 0.01 inch per hour).*

* A general wind threshold for raising of dust is considered to be 6 meters per second, equivalent to a wind speed of 13.4 mph. The actual threshold will vary with soil type, moisture, etc.

According to the Beaufort Wind Strength Scale, a Force 4 ("Moderate Breeze") is equivalent to a wind speed of 13-18 mph. (It should be noted that average annual wind speeds in southwestern and south central Kansas fall within the range of 10 - 15 mph.) It is defined as the wind strength at which dust and paper are raised from the ground. A daily averaged wind speed of 20 mph could thus be reasonably considered to continue to raise and also maintain blowing dust in the atmosphere.

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2 PUBLIC EDUCATION AND NOTIFICATION

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The following persons are usually considered to be most at risk for adverse health effects from inhalation of airborne particulate matter, and thus comprise the target population of this plan:

1) Children;
2) elderly persons;
3) individuals with impaired pulmonary function,
    a) asthma;
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    c) chronic obstructive pulmonary disease (COPD; i.e., emphysema);
4) individuals with cardiovascular disease; and
5) immunosuppressed persons.

2.2 Implementation of Education and Notification

The EPA Natural Events Policy requires public education concerning natural events. It also requires that the public must be informed whenever a natural event is imminent. EPA's Natural Events Policy memorandum states that the air quality is considered unhealthy whenever the 24-hour PM_{10} NAAQS is exceeded. Advance public notification concerning an imminent dust storm will require an accurate forecasting procedure. Since no such procedure is presently known to KDHE/BAR, it is not feasible to commit to such notification except through annual general notices.

In order to facilitate future implementation of a forecasting method and subsequent development and implementation of a public health advisory mechanism, EPA is encouraged to commit resources to relevant research. To promote timely development of such a system, KDHE/BAR are committed to support any organization in their request for EPA funding for relevant research, and to assist in evaluation of potential methods for applicability to dust storms affecting Kansas. Organizations interested in such research exist. Any forecasting/public health advisory system that proves to be both reliable and cost-effective will be considered by KDHE/BAR.

This NEAP addresses the following educational goals:

1) Educate the public about the harmful health effects of high concentrations of PM_{10}; and
2) Inform the public that certain types of natural events may affect the air quality of a given area.

These public education goals will be addressed on an annual basis through public service announcements. For this purpose, WSCDCH will issue the following statement for publication in major newspapers during January of each year:

PUBLIC NOTICE
OF
POTENTIAL ADVERSE HEALTH EFFECTS ASSOCIATED
WITH ELEVATED LEVELS OF AIRBORNE DUST

On 28 January 1996 and 4 March 1996, the Kansas Department of Health and Environment (KDHE) and the Wichita-Sedgwick County Department of Community Health (WSCDCH) measured elevated levels of particulate matter in the air in Sedgwick County, Kansas. Subsequent evaluation of this occurrence has been conducted by KDHE, and has clearly demonstrated the cause to be blowing dust associated with high winds and dry soil conditions.

During dry conditions in Kansas, there is a potential for blowing dust associated with high winds. The amount of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) contained in this blowing dust may exceed the National Ambient Air Quality Standard (NAAQS) and reach levels high enough to cause adverse health effects when inhaled. Children, elderly persons, immunosuppressed persons, and individuals with impaired respiratory and/or cardiovascular function are particularly susceptible to the adverse health effects associated with inhalation of airborne particulate matter. During natural high wind events which generate high levels of airborne particulate matter, it is advisable to limit outdoor activities and remain indoors with doors and windows closed as much as possible.

During periods of blowing dust, it is also recommended that excessive physical exertion and exposure to tobacco smoke and other respiratory irritants be avoided. Persons taking regular medications are advised to ensure that they have at least a five-day supply on hand. Individuals with chronic medical conditions should consider contacting a health care provider at the onset of any of the following symptoms: headache, repeated coughing, wheezing, chest tightness or pain, difficulty in breathing, excessive phlegm production, or nausea. It is suggested that all individuals avoid vigorous outdoor activity.

This notice is applicable when local weather forecasts indicate a possibility of high winds (sustained winds above 20 miles per hour (mph) or gusts greater than 40 mph without precipitation) in the local area.

This notification is being issued by KDHE as a public service and to assure compliance with the U. S. Environmental Protection Agency's policies related to the protection of public health in areas affected by elevated levels of particulate matter due to natural events. Questions regarding this notice should be directed to the Wichita-Sedgwick County Department of Community Health at (316) 268-8302.

3 ABATEMENT OR MINIMIZATION OF CONTROLLABLE SOURCES OF PM_{10}

3.1 Potential Sources of PM_{10} During High Wind Events

The following have been identified as potential sources of blowing dust during high wind events in Kansas. Omission of a source from this list does not preclude its future identification as a potential source.

a) Tilled agricultural land;
b) sparsely vegetated or overgrazed range land;
c) unpaved roads and parking lots;
d) urban paved roads; and
e) construction sites

3.2 Identification and Application of Best Available Control Measures (BACM)

The Natural Events Policy issued by EPA provides for identification and application of Best Available Control Measures (BACM) to sources of soil that have been disturbed by anthropogenic activities. Determination of BACM should follow EPA's technical guidance for the determination of BACM for fugitive dust sources contained in the Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures, EPA-450/2-92-004, September 1992. These BACM will be evaluated by WSCDCH in consultation with KDHE/BAR.

3.2.1 Use of conservation farming practices on agricultural lands

The following have been identified as standard soil conservation measures which constitute agricultural BACM. Omission of any soil conservation measure from this list does not preclude its evaluation and application in the future.

a) Reduced tillage farming practices;
b) tree rows;
c) other physical windbreaks;
    1) grass barriers;
    2) annual (e.g., sunflower) barriers;
    3) buffer strips; and
    4) "snow" fences;
d) cover crops;
e) strip cropping;
f) crop residues; and
g) emergency tillage

3.2.2 Abatement and suppression of dust from other sources

The following have been identified as measures which can be employed for mitigation of blowing dust

from other sources. Omission of any measure from this list does not preclude its evaluation and application in the future.

a) Application of chemical dust suppressants to unpaved roads, parking lots, and open areas with exposed soil;
b) wet vacuuming of urban paved roads and parking lots;
c) dust suppression at construction sites,
    1) water spraying of exposed soil;
    2) application of chemical dust suppressants; and
    3) use of surface coverings; and
d) restriction/prohibition of off-road vehicle activities

3.3 Undefined BACM

If appropriate BACM are not defined for contributing anthropogenic sources in question, WSCDCH should attempt to identify specific measures for implementation. This will be accomplished in two phases, 1) identification of potential mitigating measures, and 2) initial implementation by means of pilot tests for evaluation of the effectiveness of the measures.

3.3.1 Mitigating Measures

Soil erosion specialists at the federal and state levels have been working for approximately sixty years to develop and evaluate potential mitigating measures. These soil conservation experts continue to implement measures that prove effective for the reduction or prevention of blowing dust.

Numerous measures have been applied and are currently in place across the Great Plains in order to minimize the effects of wind erosion. The United States Department of Agriculture - Agricultural Research Service (USDA-ARS) Wind Erosion Research Unit (WERU) located at Kansas State University (KSU) has achieved the following:

a) Evaluated emergency till practices and demonstrated their effectiveness in halting wind erosion as it started;
b) Evaluated vegetative and non-vegetative mulches and demonstrated that standing vegetation can be five to ten times more effective at reducing wind erosion than material laying flat;
c) Evaluated the relative effectiveness of different plant species in windbreaks;
d) Established the use of feedlot wastes as an effective method for erosion control; and
e) Established the use of permanent grass wind barriers and annual crop control strips, and evaluated the relative effectiveness of their spacing, position, and size in reducing wind erosion.

3.3.2 Pilot Tests

Pilot testing and evaluation of experimental measures continue to be conducted by soil erosion specialists. These federally funded research efforts, which include experimental evaluation of erosion abatement, control, and prevention techniques, continue throughout the Great Plains.

3.4 Evaluation of BACM

The area south and southwest of Wichita, extending into northern Oklahoma, is farmland. This area was experiencing drought conditions, and the winter wheat crop had therefore not germinated, leaving bare ground in the fields. As a result of the freezing and thawing of increasingly dry topsoil, these bare areas were covered with a layer of fine loose granules (crustal dust).

It is recognized that the Sedgwick County area was influenced by high winds and blowing dust from the south and southwest. Considering the wind speeds and gusts noted during the days that concentrations above the 24-hour NAAQS were recorded (Appendix B, Table 3), it is apparent that these conditions were abnormal. The phenomena which gave rise to these blowing dust problems were, therefore, natural events which could not be prevented by application of BACM. With the top few inches of soil loose, and the lower portion frozen, the farming community was unable to apply emergency tillage or other measures to aid in the reduction of blowing dust. In fact, it is likely that these events occurred in spite of general area-wide application of accepted good agricultural soil conservation practices.

On the basis of these findings, KDHE has concluded that the Wichita area could not have prevented these exceedances at the recorded particulate levels by employing localized urban control measures. The increases in PM_{10} concentrations ranged from 634% to 1238% above normally observed levels. For example, the 28 January value of 184 ug/m^3 at the George Washington Blvd. site does not relate to the quarterly mean of 29 ug/m^3 at that site. The 28 January value of 359 ug/m^3 at the Coleman Co. site also does not relate to that site's quarterly mean of 29 ug/m^3 (Appendix B, Table 2).

3.5 Implementation Strategy

In view of the apparent regional nature of this problem, it seems clear that no single state agency has the resources or regional coverage required to increase the effectiveness of established soil erosion programs. The impact of implementation of short-term, localized control measures at the state level would be negligible when faced with the combination of conditions that resulted in the elevated levels of PM_{10} described in this plan. To be effective in reducing such dust excursions at their source, a regional systems approach which includes consideration of factors such as cropping patterns, soil types, and climatological information must be implemented. KDHE will be working closely with USDA representatives in Kansas to emphasize the continued importance of regional efforts coordinated through federal, state, and local actions directed at reducing soil erosion. Concurrently, KDHE will continue to assure that the public is

aware of the potential health consequences of elevated levels of airborne particulate.

4 PERIODIC REVIEW OF NATURAL EVENTS ACTION PLAN (NEAP)

This Natural Events Action Plan will be reviewed by WSCDCH in conjunction with KDHE/BAR at least once in every five years. The focus of this review will be the re-evaluation of conditions causing exceedances and violations of the NAAQS for PM_{10}. The review will also consider the implementation status of the plan, as well as the adequacy of actions taken. A Periodic Review Report will be prepared by WSCDCH in order to summarize the findings of the review process.

SUMMARY

The Dust Bowl was a regional problem that required intervention at the national level. There are federal agencies (and their corresponding state and local partners) with decades of experience in dealing with wind erosion of soil. Soil loss rates are much lower than they were during the Dirty Thirties, but these can be grossly elevated by high wind events during periods of drought.

The United States Department of Agriculture - Agricultural Research Service (USDA-ARS) and Natural Resources Conservation Service (USDA-NRCS) study land use, assess the condition of land, and, with the assistance of state and local agricultural agencies and organizations, develop and apply conservation measures to prevent soil loss. In Kansas, wind erosion concerns are being addressed, in part, through the USDA-NRCS Environmental Quality Incentives Program (EQIP). Morton County falls within a designated priority area (i.e., the three southwestern counties of Kansas) for which special erosion control contracts lasting three to five years have been developed. Through continued efforts, such programs have significantly reduced the annual impact of wind erosion of soil.

In light of the regional nature of blowing dust across the Plains States and the long-term federally-coordinated commitment to the problem, it would be inappropriate to create a new independent state-level authority to address this problem. No individual state has authorities or resources to implement a regional project of this nature. Application of short-term, localized control measures alone at the state level would have little or no measurable effect. Specialists in the field of agricultural wind erosion continue to emphasize that a regional systems approach which includes consideration of cropping patterns, soil types, climatological information, and other factors is required.

Only a truly regional approach coordinated at the federal level can have significant impact on events of this type that vary from state to state and have broad geographic implications. Existing federal efforts might be well-served by additional involvement in these programs on the part of EPA along with affected states as stakeholders. Funding from EPA for USDA-ARS research and USDA-NRCS application efforts (and their state and local implementing partners) could prove highly beneficial in accelerating improvements in air quality related to high wind events.

REFERENCES

1. Code of Federal Regulations, Title 40, Part 50 (40 CFR 50), Appendix K.

2. Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures; EPA-450/2-92-004; September 1992.

3. Svobida, Lawrence. Farming the Dust Bowl: A First-hand Account from Kansas; University Press of Kansas; Lawrence, KS; 1986. (Originally published as: An Empire of Dust; The Caxton Printers, Ltd.; 1940.)

4. Wind Erosion Research Unit (USDA-ARS/WERU) website at Kansas State University; www.weru.ksu.edu; 1998.

5. Newspaper Articles Concerning Dry Conditions, High Winds, and Blowing Dust; The Wichita Eagle; 30 January and 5 March 1996.

6. Wind Erosion Map; Map 1004069; USDA-SCS National Cartographic Center; Ft. Worth, TX; 1988.

7. Knapp, Mary. Kansas State Climatologist; Personal communication; Kansas State University; Manhattan, KS; 1998.

8. Nichols, Mary D. Memorandum Regarding Areas Affected by PM_{10} Natural Events; U. S. EPA; 1996.

9. Kaiser, Wayne A. Letter to John Irwin, Director, Kansas Department of Health and Environment, Bureau of Air and Radiation, Regarding Implementation of a Natural Events Action Plan for Morton and Sedgwick Counties; U. S. EPA, Region VII Office; Kansas City, KS; 24 October 1997.

14. Appendix F – Public Comments

KDHE, in following the requirements listed in 40 CFR 50.14 (c)(3)(i) **Submission of demonstrations**, posted this Exceptional Events Demonstration Package on the Agency website for public comment from December 10, 2015 until (TBD). In accordance with 40 CFR 50.14 (c)(3)(v), KDHE is documenting the public comments received in this section.

14.1 KDHE response to EPA comments

No comments from EPA have yet to be received by KDHE on this documents.

14.2 KDHE Response to Public Comments

No public comments have yet to be received by KDHE on this documents.